PLANTATION OF DALBERGIA SISSOO IN KEONJHAR STATE

BY E. S. HIGHER, FOREST OFFICER, KEONJHAR STATE (ORISSA).

Keonjhar is a State of 3,217 square miles in the Eastern States Agency. Formerly it was one of the Orissa Feudatory States and the systematic management of the forests was taken up in 1910 under the guidance of the Agency Forest Officer—an officer deputed by the Government of Bihar and Orissa. Shifting cultivation by the aboriginals, principally *Bhuians*, had gone on from time immemorial, and though the evils of this form of cultivation were realised it was not considered politic to prohibit altogether this time-honoured practice. Accordingly some 600 square miles of reserved and some 143 square miles of protected forests were demarcated for systematic management, and the *Bhuians* were allowed 500 square miles in the hill tracts where they could continue to live without restriction of their former rights. This area of 500 square miles, known as *Bhuianpirh*, forms the catchment area of the Baitarani River which flows into the sea about 45 miles from Cuttack.

In 1927, 24 inches of rain fell in the Bhuianpirh within 24 hours. The denuded hill slopes were incapable of preventing the rapid run-off of the water, and the result was the covering of large areas of culturable land on the banks of the Baitarani with sand several feet deep, rendering them unfit for cultivation.

In 1929 it was suggested that an experiment should be tried of planting up with *sissoo* (*Dalbergia sissoo*) and *Casuarina*, such areas as were unfit for reclamation. An area of 200 acres was chosen in a locality with no other forest areas in the vicinity. *Sissoo* seed was obtained from the Silviculturist, United Provinces, and *Casuarina* seed from the Divisional Forest Officer, Puri.

In April 1930 the seeds were sown in a nursery on the river bank, and planting out was commenced in September. The *sissoo* by then was on an average 12 inches in height; the *Casuarina* was slower in growth and was less than six inches when transplanted

into pot tiles and put out in the plantation area. Planting was done 10′ by 10′ with alternate rows of *sissoo* and *Casuarina* and arrangements were made for watering the plants daily from temporary wells sunk in the plantation, 110 acres were planted in the first year. The *Casuarina*, although not suffering many casualties, did not do so well as the *sissoo* and the conclusion was that the former had been put out too early. By the winter of 1931 the *sissoo* had attained an average height of 5 feet, some of the plants being 8 feet, while the tallest *Casuarina* was 4 feet and the average only 2 feet.

The remarkably good growth of the *sissoo* continued and by November 1932 it had an average height of 20 feet. By contrast the *Casuarina* was not doing at all well, and it became obvious that while the *sissoo* had got through the sand to the fertile sub-soil below, the *Casuarina* was still struggling to do so. Because of this contrast, and the fact that the *Casuarina* had begun suffering many casualties, fresh areas were planted with pure *sissoo* and the casualties among the *Casuarina* replaced by *sissoo* root and shoot cuttings, which did well. But over an area of about 2 acres both *sissoo* and *Casuarina* were doing very badly; the growth was stunted with profuse side branches. Pits were dug in this area to test the depth of sand and it was found to vary from 9 to 12 feet, while tests in the area where the *sissoo* was doing so well showed the depth of sand to vary from 2 to 5 feet.

By 1933 the 200 acres were fully stocked and since then work has mainly consisted in the replacement of casualties and the collection of the data as regards the rate of growth in relation to the depth of sand. Sample trees have been selected, the depth of sand near each has been measured, and height and girth measurements are being recorded annually. In the area planted in 1930 some of the *sissoo* is over 50 feet with stems 24 inches in girth. Light thinnings have been done to remove crooked superfluous stems and some stems which were infected with *Loranthus*. There is a ready sale for the cut material. This year *sissoo* seed collected from the plantation was sown in the nursery side by side with seed obtained from Naini

Tal and it is interesting to see that the growth from the local acclimatised seed is appreciably faster.

In the course of 8 years since the floods the sand outside the plantation has become covered with a dense growth of *tandi* grass (*Saccharum spontaneum*) over considerable areas and this has invaded the areas of the plantation where the sand is deep. It interferes with the growth of young *sissoo* plants, is difficult to eradicate, and persists until the *sissoo* has grown enough to form a canopy ; so in taking up areas covered with *tandi* grass, unless plant growth is rapid, the keeping down of the grass becomes an important factor in the cost of formation.

The experiment has been a success and has already given useful data for the formation of future plantations in similar areas. It has shown that *sissoo* is a suitable species for such areas, and is to be preferred to *Casuarina ;* but up-to-date the indications are that it is not worth while taking up areas where the depth of sand is more than eight feet.

NOTE

Mr. Higher's article on "Plantation of *Dalbergia sissoo*" is highly interesting. This species whether raised artificially or growing naturally generally grows very fast in similar localities—as for instance in Bettiah forests along the Gandak in Champaran District (Bihar). A narrow strip on either side of the Gandak has been and is still subject to fluvial action and this locality represents typical alluvial *sissoo* forests. Here this tree grows more or less gregariously. Before *sissoo* makes its appearance or simultaneously with it, the new land is covered by grass—chiefly *Sachharum munja*. In some cases before the advent of *sissoo*, *Tamarix gallica* also makes its appearance. When *sissoo* comes up in dense masses it kills out grass. This natural movement is, however, interrupted by other factors such as fire and fellings. Gradually a mixed forest of *sissoo* with *Holarrhena antidysenterica*, *Odina wodier* and *Bombax malabaricum* arises. The main point, however, is that in this locality it is quite common to see 30-year-old *sissoo* trees of 5′ in girth and over 60′ in height.

I do not agree with Mr. Higher when he says that the reason why *Casuarina* is not doing well in his plantation is because it has failed to reach the fertile sub-soil below, while *sissoo* which is doing much better has already reached such a sub-soil. The fast growth of *sissoo* may be due to this reason, but *Casuarina,* which grows well on sea beaches, as in Puri (Orissa) where sand is found to a great depth and where no other vegetable growth worth the name is found, can not possibly be adversely affected by a few feet of sand. The reason for the failure of *Casuarina* must therefore be sought elsewhere.

L. R. SABHARWAL,

Working Plans Officer, Bihar and Orissa.

[We entertained serious doubts about sissoo attaining a height of 50 feet and stems 24 inches in girth in about 5 years. In fact the figures were so abnormal that we did not for a moment believe that it was anything but a typing mistake and consequently referred to Bihar and Orissa and we have now the testimony of two officers in that province who personally vouch for the correctness of the figures. One of them was present when the measurements were taken and so there is no doubt about the measurement which must be a record. This has beaten the F. R. I. records.—ED.]

EARTHQUAKE-PROOF BUILDINGS

BY R. MACLAGAN GORRIE, D.Sc., I.F.S.

The publication of Mr. W. D. West's report on the Quetta earthquake should be of interest to all foresters throughout the northern parts of India and Burma in at least two ways, namely, in the possibilities of locating further shocks and in the best means of safeguarding our departmental buildings.

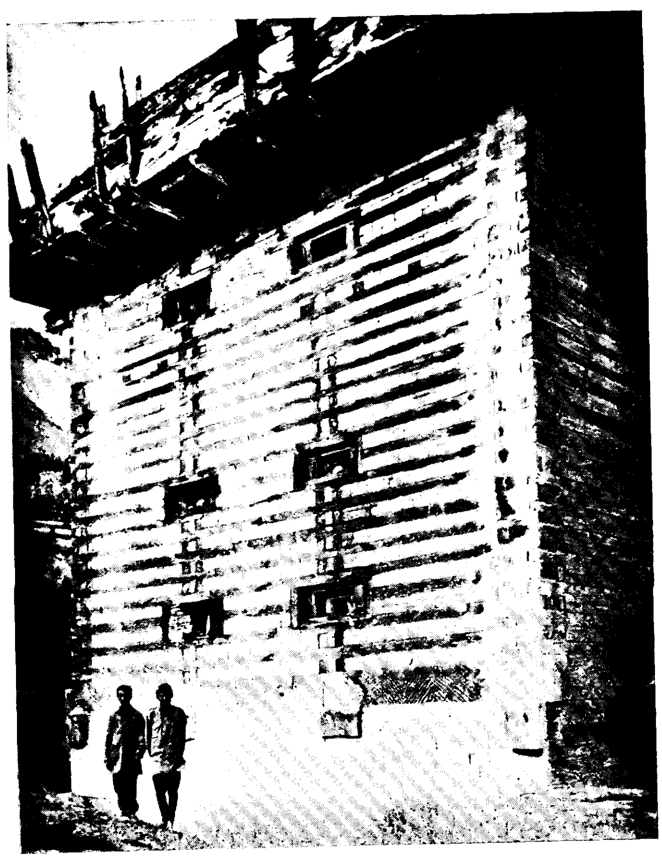
The growing pains of the Himalayas are by no means finished, as the history of recent earthquakes shows:—Assam in 1897 with 20,000 deaths; Kangra in 1905 with a further 20,000 casualties; the Bihar 'quake of last year with its 7,000 deaths and enormous and

widespread loss of property; and, lastly, the Quetta disaster with its sudden and very local damage. A comparison of Mr. West's findings with those of Mr. C. S. Middlemiss on the Kangra earthquake of 1905 (*Mem. Geol. Surv. Ind.* xxxviii, 1910) indicates that the epicentres were at points where the usually straight line of the Himalayan thrust-plane is interfered with by some irregularity. To appreciate this, one has to picture the effect when the two great land blocks of peninsular India and the Tibetan plateau move against each other; any excrescence on the general alignment of the opposing blocks gets in the way, and forms the epicentre of a local disturbance. Thus in the Kangra 'quake there were two centres, one at Dharmsala, and one at Mussoorie, both points where large bays or re-entrants are formed by the younger tertiary rocks of the lower foot-hills running up into the metamorphic older rocks of the higher hills. In the case of Quetta Mr. West indicates a bay of peninsular strata running up into a narrow triangular gap between the adjoining higher ranges.

Such irregularities formed of softer and younger rocks must obviously bear the brunt of any readjustment in the levels of the two great opposing land blocks, and these and similar points will sooner or later prove to be the centres of further movement. In fact one might suggest to the honorary editor that he could raise some funds and a flutter of excitement by floating a sweepstake with *Indian Forester* coupons, the lucky winner being some worthy with a hunch for geological soothsaying who could foretell the exact epicentre of our next earthquake! Let us hope, however, that the funds would remain a long time in some fruitful bank deposit before the next one occurs and the prize could be awarded.

Both these reports emphasise the need for making all buildings as earthquake-proof as possible, for undoubtedly many of the casualties in both cases could have been avoided if buildings had been better constructed. We must leave to the P. W. Department and the military the joys of planning and erecting steel and concrete sky-scrapers which will withstand any vibration, but in our departmental buildings much can be done to make them safer without unduly increasing their cost.

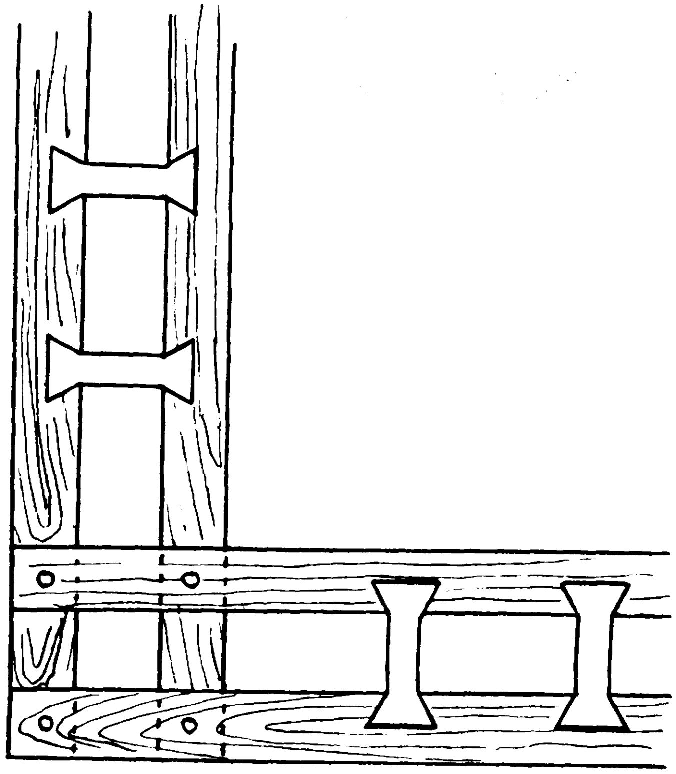
A dilapidated house wall in which the deodar binding beams are supporting the entire weight of the structure.

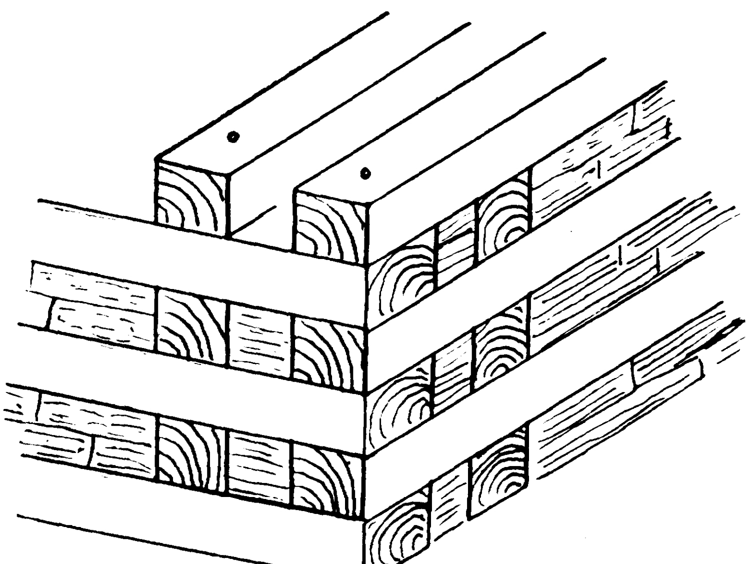


Morang Fort in the Sutlej Valley, said to be at least 400 years old, with its walls of *kat-ki-kona* still in perfect condition.

Photos : R. M. Gorrie.

EARTHQUAKE PROOF BUILDINGS





Kat-ki-kona wall construction.

Rounded river-borne boulders are a fruitful source of trouble, as they are less effective than even sun-dried bricks in resisting any shock. Timber used indiscriminately as a substitute for stone without any special bonding process is more or less wasted, but if properly used to exploit its great tensile strength, our local timbers are invaluable in buildings.

The best type of building in the Punjab hills, and one which everywhere withstood splendidly the severe test of the 1905 earthquake is the *kat ki kona* (timber cornered) frequently seen in Kulu, Kanawar, Mandi, the higher Kangra hills, and also in the neighbouring United Provinces hill country. Two parallel squared beams, generally of deodar, are laid along the line of masonry, one outside and one inside; at the end of one wall these are crossed by those in the wall at right angles, and wooden pins hold the crossings together; cross-ties of wood are dove-tailed in at intervals to hold the parallel beams in position, and all gaps are packed with rubble; long slabs of shaped stone alternate with the beams (diagrams). This type of half timber construction combines the weight, solidity and coolness of a stone building with the flexibility and tensile qualities of timber. The resisting power of the wood is proved by the survival of such *kat ki kona* structures to a very great age, as, for instance, the old Tibetan fort at Morang, far up the Sutlej valley on the Tibetan border, said to be at least 400 years old, and with its walls still in perfect condition.

Next best thing to the *kat ki kona* is the more common type of " half-timbering," in which the timber is not by any means a half, but with wooden beams put in at vertical intervals of about 3 feet, and pinned to their neighbours in the crosswalls, the intervening dry masonry being of well matched square-cut stones. Where small slate rubble is used as packing, any shifting of the building puts an undue strain upon the wooden beams, but even so, the tensile strength of the wood is usually sufficient, as is well shown in the illustration of a dilapidated house wall (Plate 2) now depending entirely upon the deodar binders.

Where white-ant resistant timbers are scarce or dear, much might be done on these lines with the use of inferior woods treated with creosote or a preservative salt solution, but the notches and pin holes would have to be cut before treatment, not after.

The use of *dhajji* walls for interior partition walls is also a form of insurance as well as a saving of space. This is made of a framework of squares and triangles of planking, generally 4—6 inches deep, and nailed or notched together, with the spaces between each plank packed with rubble and mud plaster.

SEED ORIGIN AND ITS IMPORTANCE IN INDIAN FORESTRY

By M. V. Laurie, I.F.S., Central Silviculturist

Mr. Joshi in his article under the above title in the October issue of the *Indian Forester* makes a vigorous plea for the wider recognition of the importance of this subject, and everyone will agree that it is very important and is frequently neglected by the average forest officer in his regeneration work. Mr. Joshi's statement that the subject is "completely lost sight of and never considered" is, however, far from being true. Seed origin studies have featured on the research programmes of the Central Silviculturist and several Provincial Silviculturists for a number of years. The matter was discussed at considerable length at the 1929 Silvicultural Conference, and as a result of the resolution then passed, Mr. Champion collected all available information on the subject both from European and Indian sources and published it as an Indian Forest Record (Vol. XVII, Pt. V) entitled "The importance of the origin of seed used in Forestry." This may be referred to as the most comprehensive and up-to-date summary of our present knowledge of the subject.

A co-operative investigation in which all teak-growing Provinces and some Indian States also are participating was started into the effect of the origin of teak seed on its growth. The investigation involves two kinds of experiments, namely short-term experiments for determining the behaviour of the different origins as regards

germination and early growth so as to ascertain their suitability for plantation work as far as ease and cost of establishment are concerned. A second set of long-term investigations are also being carried out to determine rates of growth up to maturity, bole form and timber quality of the trees from the different origins, as well as their general suitability to localities and conditions differing from those of its natural home. (A review of these experiments summarising the results up-to-date has been published in the proceedings of the 1934 Silvicultural Conference). At Dehra Dun further experiments into the inheritance of various characters are being carried out for nine or ten different species. A number of recent working plans, notably in Madras, prescribe the sources and the types of trees from which seed may be obtained for plantation works, and in some cases even prescribe the marking and preservation of selected seed-bearers. It is scarcely true, therefore, that the subject is not receiving any consideration.

All the same, it would appear to be desirable that further steps should be taken to ensure that when seed is obtained from outside sources, whether from another division in the same province or from other provinces, it comes from a reliable source. Every ranger knows how much easier it is to collect seed from low crowned branchy trees which frequently bear more prolifically than tall straight well-grown trees. Usually when an order for seed is received by a Divisional Forest Officer it is passed on to a ranger for compliance, and he sends it to a forester who tells a forest guard to get some coolies and go and collect the seed. The bags come in and are duly despatched, but probably the forester and the ranger, not to mention the Divisional Forest Officer, are ignorant of the kind of trees from which the seed has been collected. So also is the recipient of the seed who makes his plantation and watches its early growth with pride, and happily retires before the true growth form of the trees becomes apparent. Several cases have been seen where bad branchy or twisted trees have been produced in plantations raised from seed which, on enquiry, has been found to have come from bad sources, and it should be made an offence to supply seed from a doubtful source

without informing the recipient about it. It requires a good deal of trouble and supervision to ensure that seed is collected from reliable sources, and the responsibility must rest primarily with the ranger who, in the course of his work about the forest, should keep a look-out for good seed-bearers of all valuable species and make a note of them, so that he can direct his subordinates where to go when the indents come in. The advantages of selected and permanently marked seed-bearers are obvious. Indenting officers would do well to demand a certificate of origin of the seed, and Divisional Forest Officers also could, with advantage, insist that the rangers should always certify that the seed they collect both for their own regeneration work and for export should be accompanied by a certificate that it has been collected from well grown healthy trees of good bole form and free from twist or any other defects that are likely to be hereditary and affect timber quality.

It is not intended by the above to convey the impression that all bad growth form in trees is inherited, or that by collecting seed from good trees you will get only well-formed offspring. Our knowledge of what characters are inherited and what are not is still very limited. Bad form which has been induced by unfavourable growth conditions during the life-time of the parent tree is almost certainly not passed on to the next generation, whereas certain definite types of growth, *e.g.*, twisted fibre, virgate habit, etc., and those which can be recognised as definite sports or mutations are very likely to be inherited. In nearly all trees, moreover, only the female parent of the seed is known. Most trees are cross-pollinated by wind or insects, and the source of the pollen cannot usually be determined. Hence the selection of well-formed parent trees by themselves is likely to be only half a solution of the difficulty, and preference should be given to seed from localities where the form of the majority of the trees is good.

The arguments mentioned above apply chiefly to the collection of seed in the locality where the plantations are to be formed. Local collection is to be preferred where possible as the plants are more likely to be suited to the climatic and soil conditions. On the other

hand, however, when the local race has poor growth form, and where other races having better growth form are available as sources of seed in different localities, it is well worth investigating to determine whether such better races can be introduced under conditions differing from those of its original habitat.

A brief classification of the types of characters we are concerned with may not be out of place here. For a fuller discussion of them Mr. Champion's Record on the subject may be consulted.

(*i*) Seed collected in one forest or restricted locality.

1. Effect of size of seed or fruit.
2. Effect of age, size, dominance and vigour of parent trees.
3. Effect of morphological variations, (*e.g.*, twist, branchiness, bole form, figured grain, proportion of heartwood, etc., and congested clumps or solid culms in bamboos).
4. Effect of phenological variations, (*i.e.*, times of leaf fall, new leaf production, growth periods, etc., etc., chiefly as affecting suitability to other localities with differing seasonal changes, but also as regards local growth).
5. Effect of physiological variations, (*i.e.*, resin yield in pines, oil yield in sandal, *katha* in *Acacia catechu*, etc).
6. Effect of sports and mutations, etc.

(*ii*) Seed collected in different localities.

7. Geographical races.
8. Altitudinal races.
9. Soil races.

(The above classification has been adapted from Mr. Champion's publication).

Mr. Minchin, in a letter published elsewhere in this number, enquires about the effect of seed size, and also what the functions of a seed testing station such as Mr. Joshi advocates might be.

A considerable amount of work has been done on the effect of the size of the seed or fruit on the development of the resulting tree, and the general result has been arrived at that large seed gives a higher germination and plant percent and larger and stronger

seedlings than small seed. In some species the larger the seed the better the results while in others only small seeds below a certain size give inferior results, increase in seed size above that point conferring little or no advantage. These differences tend to disappear in later development but it is probable that in sowings of ungraded seed the majority of dominants originate from the larger seed. These conclusions apply to seed having a single embryo, but they do not apply to teak which is exceptional in having anything from 1 to 4 embryos per fruit. Varying results have been reported regarding teak "seed." Burma has found that generally larger "seed" (=fruits) give better results. Madras has found that sometimes large, sometimes small, but most often average sized fruits give best germination and development, but that none of the differences can be considered significant. Other provinces have reported varying results. The explanation for these conflicting results is probably that a small teak fruit more often has a single seed of good size in it than several seeds of small size, whereas a larger fruit is more likely to contain two or three seeds of moderate development rather than one of exceptional size. In any case, it has been found unnecessary and wasteful in the case of teak to discard undersized fruits—a practice which was common until recently.

Regarding Mr. Joshi's suggestion that every province should have its own seed testing station run on up-to-date scientific lines, it would be interesting to hear from him what he had in mind as to the functions such a station could usefully perform. Where large afforestation projects depending on imported seed are being undertaken, the testing of each consignment of seed for germination and purity is an important matter, especially where the seed is expensive. It is quite impossible however by seed testing to exercise any check whatever on the origin of the seed or its hereditary suitability since such characters are not usually observable in the young seedling. The importer must simply rely on the good faith of the supplier in such matters and accept the statements given in the certificate of origin which, as suggested above, could with advantage be made compulsory.

FORM FACTORS FOR KOSH (ALDER) FIREWOOD

By I. D. Mahendru, P.F.S.

In the May issue of the *Indian Forester* for the current year I have come across a statistical contribution, under the headline—"Form Factors for Kosh (Alder) Firewood." This article deserves notice, on account of an uncritical acceptance of the results obtained.

Leaving aside in referring to a *conversion* factor as a *form* factor, the statistical significance of the comparative results based on the measurement of two single stacks of 100 c.ft. each, one of split wood and the other of branch wood, is open to serious objection. For it is an accepted principle that any experiment initiated to give comparative results should be designed not only to provide an expression of the differences sought for, but also, by means of adequate replications, a measure of the variations involved due to uncontrolled or accidental factors, with which to compare the differences in order to judge their significance. Considered in this manner, a difference of the order of 50 per cent. may not be significant, while a much smaller one may be so, depending upon comparison with the inherent measure of variation due to fortuitous factors as specifically provided by the experiment itself.

In the case in hand, the dry-weight factor for split wood is calculated at 61 per cent. of the original weight, and of the branch wood at 62 per cent. Is this difference of 1 per cent. significant? There are no replications in the experiments, so one can only make use of the laws of pure chance as the basis of comparison. The error, e, of a ratio p is $\pm\sqrt{\frac{p-p^2}{n}}$, and of the difference between two ratios $\sqrt{(e_1{}^2+e_2{}^2)}$, where e_1 and e_2 are the separate errors of these two ratios. The differences are considered significant when the numerical value of the difference is greater than at least twice the error. The error in this case is $\pm$ 0·62 per cent., and 2 $\times$ 0·62 is greater than 1 per cent., the observed difference, showing that the

results are far from significant. The statistical conclusion is that only a single factor, the mean of the whole data should be accepted for use, unless by further amplification of the experiment the differences are established as significant. As it now stands the observed difference is of an order of magnitude which is very frequently exceeded by chance.

[NOTE.—We do not consider the writer of the original article had made any effort or intended to prove that the difference between dry weights of split and branch wood was significant. All he wished to convey was that the dry weight of both split and branch wood was roughly 61 to 62 per cent. of the original weight of green wood. We recognise, though, that this percentage was based on too meagre a data.—ED.]

A BRIEF DESCRIPTION OF THE GALIS FOREST DIVISION, HAZARA, N. W. F. PROVINCE

By Riaz Ahmad, I.F.S.

The Galis Forest Division stretches almost from Taxila along the territorial limits of the Punjab and N. W. F. P. to Barian and thence follows the Galis mountain ridge to Thandiani and on to Mansehra. River Jhelum flows along the north-eastern boundary of the Galis and Thandiani Ranges.

The Division embraces practically the whole of Lower Hazara and tracts around Taxila and towards Haro Basin in Lower Khanpur, which were the centre of Taxilian civilization. With but brief intervals, the tract has been subject to various invasions and has seen succession of civilizations. Most of the arable land is confined in and around Khanpur. In the interior, wealth is still reckoned by cattle and goats.

The rock in Khanpur area is composed predominently of close grained, hard dolomitic lime-stone and conglomerate with occasional out-crops of shales and ferruginеous sand-stones. The tract is

characterised by bare sheets of rock or loose boulders, which abound on steep southernly slopes and on the tops of well defined ridges and main spurs. Consequently the soil covering is shallow and dry and subject to rapid variation of temperature. In some places, however, the rock is interspersed with other formations and results in considerable quantity of mineral soil. Average annual rainfall is about 31 inches.

The brushwood forests of Lower Khanpur are in the main composed of *Dodonea viscosa*, *Olea cuspidata*, *Acacia modesta*, *Carissa spinarum*, and to a lesser degree of such species as *Mallotus philippinensis* and *Bauhinia variegata*. Stray specimens of hosts of other species of little practical importance are also found in these forests. Brushwood areas are poorly stocked and taken as a whole are of little commercial value. In the forests near Taxila, however, a day's work is often made lively by finds of broken old pottery or ancient relics and interviewing equally "ancient" and "broke" *khans*.

The objects of the management in the brushwood forests are to improve the growing stock and to increase the proportion of olive and *Acacia modesta* as the area is subject to heavy incidence of grazing. Efforts have recently been made to introduce species considered to be immune from browsing, such as mesquite. Attempts are also being made to provide the agriculturists with an alternate means of fodder and with this end in view experiments to grow and cultivate sunflower for fodder are being conducted. The brushwood forests are mainly confined to altitudes between 1,800 and 3,500 feet.

As we rise along the Haro Basin, *Pinus longifolia* makes its appearance at an altitude of about 3,500 feet. It is found almost exclusively on northern aspects and goes up to 6,000 feet, where it gradually merges into blue pine. The rock and soil are similar to brushwood areas but the rainfall increases progressively and is about 64 inches at the extreme upper end of Khanpur mountain chain where it joins the Galis ridge. The growth of the chir is poor

throughout the tract. Occasionally patches of well grown trees are found where the accumulated soil has attained a good depth. The chief associates of the chir in these forests are *Quercus glauca* and *Quercus incana* with sprinkling of other broad leaved species among which *Machilus*, *Celtis australis*, *Zanthoxylum alatum* are quite prominent. The most common shrubs are *Berberis* and *Lonicera quinquelocularies*. Chir regenerates fairly well under shelterwood compartment system. Our main difficulty is to safeguard these areas against frequent fires which occur in these parts. Controlled winter departmental firings of 8 to 10 years old chir regeneration has been tried with very encouraging results. Broadcast sowing of chir seed in blanks after lightly raking the soil has also proved a success.

The forests in Galis proper and Thandiani consist of silver fir and blue pine and are found at all elevations between 6,500 feet and 9,500 feet. The mixture varies from almost pure blue pine crop of varying proportions to almost pure silver fir. The majority of silver fir is found on northern aspect, where this species begins at comparatively low level. Scattered decandent specimens of *Cedrus deodara* are quite common in some of the Galis forests. Judging from the charcoal obtained from many of the burnt Taxilian buildings, which on examination has invariably proved of deodar wood, it seems probable that in the past the proportion of deodar was far higher in these forests. The yew (*Taxus bacata*) is a prominent associate of silver fir. Among the fast disappearing but at one time abundant hardwoods, *Quercus dilatata*, *Quercus semicarpifolia*, *Acer caesium*, *Aesculus indica*, *Juglans regia* and *Prunus padus* are found almost everywhere.

The rock in the forest area consists predominently of lime-stone with frequent out-crops of shale at lower elevations. Nallas and depressions contain deep rich soil mixed in many places with lime-stone boulders. Average annual rainfall is about 60 inches. May, June, September and October are the worst drought months.

Blue pine has failed to regenerate satisfactorily under shelterwood compartment system in many of these forests with the result that

there is little to come out in the next felling cycle. Attempts have been made from many angles to tackle this problem. Until recently it was considered that the intensity of felling was far too high in most of the early felled areas and considerable number of experiments were carried out to determine the correct intensity of seeding felling. The sacrifice of hardwoods was almost entirely stopped both for maintaining the mixture and for the protection of young blue pine regeneration during the drought period as well as to maintain the fertility of the soil. Whatever the causes of failure of blue pine regeneration, it is beyond dispute that in some of the heavily felled areas of past years, the soil having undergone progressive changes, as evidenced by a succession of herbs and shrubs, has now attained a condition in which blue pine regeneration has started to come in with comparative rush inspite of the mother trees being about 80—90 feet apart. At present much of the soil in these areas is covered by wild strawberry, one of the factors indicative of the apparent suitability of soil for reception of blue pine seed. It seems probable, therefore, that the factors of overhead shade and the incidence of seed have been exaggerated in the past. Nor have we fully realized the bewildering variety of consequences that are likely to follow as a result of upsetting the equilibrium of nature by progressive disappearance of hardwoods in these forests. The Working Plan mentions the irresistible in-rush of blue pine in many fir areas. One is at present struck with the slow but steady invasion of silver fir in not a few of the predominent blue pine forests. This phenomena cannot apparently be explained on the basis of steady disappearance of hardwoods, nevertheless it has probably some subtle bearing on the problem. These few observations are given not with the idea of derogating what has been done and accomplished in the past, but rather to temper dogmatism in the future.

Naturally as a result of the failure of regeneration to keep pace with the fellings, considerable amount of artificial work has had to be done. About one lakh deodar seedlings are raised annually in the permanent nurseries in the two Galis Ranges and considerable area is sown with deodar seed in suitable localities.

Walnut sowing and planting has given very encouraging results. The method of putting out walnut cuttings in wire mesh cylinders in vole infested areas has proved an unqualified success.

Poplar and *Salix* cuttings in suitable localities have also given fairly good results.

The District is remarkably poor in all kinds of game. Chakor and pheasants were quite common at one time, but between falconery, shikari dogs and innumerable guns, there is little left to shoot. When fresh to the Division one is liable to fall a victim to an over-enthusiastic Rest House chaukidar who having lured you into the forest after a hard day's inspection with the promise of a huge bag, explains with a sheepish grin on the way home at night that Providence had recently become over-solicitous for the protection of the feathered denizens of these parts and it was pre-destined that we should return empty handed.

Table showing the inland trade in Teak between each Province and Indian States and Chief Seaports (in cubic feet) during the month of September, 1934, and in the 6 months 1st April to 30th September 1934.

Articles and whence exported.	IMPORTED INTO PROVINCES, EXCLUDING SEAPORT TOWNS, INTO STATES AND CHIEF SEAPORTS.									
	Assam.	Bengal.	Bihar and Orissa.	United Provinces of Agra and Oudh.	Punjab.	Sind and British Baluchistan.	Central Provinces and Berar.	Bombay.	Madras.	Rajputana.
TEAK—										
Assam	..	..	..	..	..	..	..	..	..	..
Bengal	71	..	213	..	..	..	..	..	..	..
Bihar and Orissa ..	..	..	..	..	..	..	..	..	..	..
United Provinces of Agra and Oudh	..	..	..	..	..	..	..	..	..	..
Punjab	..	..	..	100	..	..	..	..	..	133
Sind and British Baluchistan	..	..	..	..	25	..	..	..	..	..
Central Provinces and Berar	..	..	..	776	1666	..	..	1541	9955	..
Bombay	..	..	..	..	..	..	..	..	5529	3
Madras	..	..	..	..	..	..	..	60	..	..
Rajputana	..	..	..	..	..	..	..	..	..	..
Central India	..	..	..	..	..	..	5	27	..	..
Nizam's Territory ..	..	..	..	..	..	..	..	302	2652	..
Mysore	..	..	..	..	..	..	..	..	890	..
Kashmir	..	..	..	..	..	..	..	..	..	..
Calcutta	844	6344	3421	5274	16333	..	16	..	..	..
Bombay Port	..	..	..	..	1116	623	19	58916	..	959
Karachi	..	..	..	..	3855	12723	..	..	..	9
Burma	..	505876	..	..	..	95497	..	407086	202030	..
Madras Port	..	..	..	..	..	..	..	..	49016	..
Total for September 1934 ..	915	512220	3635	6150	22995	108843	41	467933	270072	1105
Total for six months, 1st April to 30th September 1934	1972	2278238	30748	40344	176482	465824	812	2480778	2228986	55340

NOTE.—1 maund=1·78 c. ft.

Table showing the inland trade in Teak between each Province and Indian States and Chief Seaports (in cubic feet) during the month of September, 1934, and in the 6 months 1st April to 30th September 1934.

Articles and whence exported.	IMPORTED INTO PROVINCES, EXCLUDING SEAPORT TOWNS, INTO STATES AND CHIEF SEAPORTS.									
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Karachi.	Madras Port.	Total for September 1934.	Total for six months 1st April to 30th September 1934.
TEAK—										
Assam	..	..	..	..	..	..	..	..	..	228
Bengal	..	..	..	..	..	..	..	..	285	2276
Bihar and Orissa	..	..	..	..	..	..	..	..	..	2832
United Provinces of Agra and Oudh	..	..	..	..	..	..	..	..	..	14986
Punjab	..	..	..	..	..	..	..	..	233	7689
Sind and British Baluchistan	..	..	..	..	..	..	..	..	25	564
Central Provinces and Berar	64	18047	..	..	..	..	..	..	32051	184883
Bombay	..	1386	2672	..	..	48	..	..	9639	202621
Madras	..	1785	173	..	..	..	..	1059	3078	54083
Rajputana	9	..	..	..	..	..	..	..	9	11
Central India	..	..	..	..	..	..	..	..	32	1287
Nizam's Territory	..	..	..	..	..	..	..	..	2955	35376
Mysore	..	..	..	..	..	..	..	..	890	10180
Kashmir	..	..	..	..	..	..	..	..	..	35
Calcutta	7	..	..	..	..	..	..	..	32239	258483
Bombay Port	16	2250	555	..	..	..	..	..	64455	331742
Karachi	..	..	..	..	..	..	..	..	16588	83482
Burma	..	..	..	..	..	..	..	..	1210489	6475551
Madras Port	..	468	8832	..	..	..	..	..	58316	388289
Total for September 1934	96	23937	12232	..	..	48	..	1059	1431284	..
Total for six months, 1st April to 30th September 1934	32675	147281	78774	173	139	5780	9	39185	..	8063540

NOTE.—1 maund=1·78 c. ft.

Table showing the inland Trade in other Timber between each Province and Indian State and Chief Seaports (in cubic feet) during the month of September, 1931, and in the six months 1st April to 30th Sepember 1931.

Articles and whence exported.	Imported into Provinces, excluding seaport towns, into States and Chief Seaports.									
	Assam.	Bengal.	Bihar and Orissa.	United Provinces of Agra and Outh.	Punjab.	Sind and British Baluchistan.	Central Provinces and Berar.	Bombay.	Madras.	Rajputana.
OTHER TIMBER—										
Assam ..	..	62314	2104	347	..	..	..	..	..	..
Bengal ..	10717	..	19820	2435	7449	..	..	..	..	..
Bihar and Orissa	32	100111	..	29475	28	1369	3982	..	19842	3627
United Provinces of of Agra and Oudh	..	972	29605	..	65584	29423	..	..	..	45990
Punjab ..	2	..	2	33216	..	32814	11	726	..	13416
Sind and British Baluchistan ..	..	..	..	..	33060	..	..	..	..	477
C. P. and Berar ..	..	1771	2396	6773	5885	..	..	44655	6912	11376
Bombay ..	..	..	..	..	..	..	221	..	7026	10068
Madras ..	..	..	..	..	..	..	..	5642	..	2
Rajputana ..	..	..	..	80	180	1297	..	126	..	..
Central India ..	..	..	..	4069	2768	..	142	5	..	69
Nizam's Territory	..	..	..	..	..	..	..	393	7476	..
Mysore ..	..	..	..	..	..	..	..	2268	6345	..
Kashmir ..	..	..	..	..	238	..	..	..	..	..
Calcutta ..	495	66107	9596	3407	80	..	..	..	34	2
Bombay Port ..	..	..	..	215	123	..	883	19347	78	365
Karachi ..	..	..	..	5	1661	19502	..	..	..	972
Burma ..	..	218228	..	..	..	33464	..	9256	4272	..
Madras Ports ..	..	..	..	..	..	..	..	358	24884	..
Andamans ..	..	193931	..	..	..	..	..	..	71556	..
Total for September 1934 ..	11246	643434	63523	80023	117056	117870	5238	82777	148425	86364
Total for six months 1st April to 30th September 1934	145798	2469434	855473	1117624	1754861	570630	73777	1219711	104291	840397

NOTE.—1 maund=1·78 c. ft.

Table showing the inland Trade in other Timber between each Province and Indian State and Chief Seaports (in cubic feet) during the month of September, 1934, and in the six months, 1st April to 30th September 1934.

Articles and whence exported.	Imported into provinces, excluding seaport towns, into states and chief seaports.										
	Central India.	Nizam's Territory.	Mysore.	Kashmir.	Calcutta.	Bombay Port.	Karachi.	Burma.	Madras Ports.	Total for September 1934.	Total for six months, 1st April to 30th September 1934.
OTHER TIMBER—											
Assam ..	..	..	..	..	11511	..	..	..	..	76276	576462
Bengal ..	..	..	..	..	73261	..	..	59183	..	172868	1200097
Bihar and Orissa	7782	..	..	..	16613	..	..	..	2659	185520	2057739
United Provinces of Agra and Oudh	1799	2	..	..	3	302	..	..	..	173682	2548024
Punjab ..	5	..	..	1878	..	78	767	..	..	82916	530899
Sind and British Baluchistan	..	..	..	..	1025	..	1192	..	..	35755	49436
C. P. and Berar ..	7086	..	..	..	2	7	..	..	..	86862	1645071
Bombay ..	..	4017	110	..	..	9263	..	..	1264	31969	517317
Madras ..	50	3273	9767	..	..	2	..	..	85992	104728	715903
Rajputana	25	..	..	..	..	30	..	..	..	1739	36351
Central India ..	..	..	..	..	..	165	..	..	..	7220	176861
Nizam's Territory	..	..	..	..	..	..	..	..	..	7869	207560
Mysore ..	..	..	..	..	..	..	..	..	2284	10897	132914
Kashmir ..	..	..	..	..	..	..	..	..	..	238	9106
Calcutta ..	..	..	..	..	..	..	..	..	..	79722	246984
Bombay Port ..	441	1048	201	..	100	..	..	..	59	22860	172126
Karachi ..	7	..	..	12	..	..	..	..	..	22159	87567
Burma ..	..	..	..	..	..	..	..	..		265220	984251
Madras Ports ..	..	1207	1358	..	..	..	..	..	..	27807	177341
Andamans ..	..	..	..	..	..	..	..	..	..	265487	584819
Total for September 1934 ..	17196	9548	11436	1890	102515	9849	1960	59185	92257	1662979	..
Total for six months, 1st April to 30th September 1934	364551	108786	122076	11944	990298	139004	16413	189570	629369	..	12473070

NOTE.—1 maund=1·78 c. ft.

SOIL EROSION IN NIGERIA

By J. R. Ainslie,
Conservator of Forests, Nigeria.

This very interesting report, written for the British Empire Forestry Conference, South Africa, 1935, adds yet another country to the long list of those suffering from the results of disforestation. Nigeria is described as a vast undulating plain rising northwards from the seaboard to a plateau averaging 2,000 feet in height which, to the north, borders on the Sahara of French Sudan. Towards the north-east there is an inland drainage system through a great alluvial plain to L. Chad, the central and southern tracts are drained by the depressions of the Niger and Benue rivers.

During the rainy season, April to October, heavy rain, varying from 60 to over 300 inches, is experienced along the coast, but precipitation rapidly diminishes inland, and in the north it is under 30 inches.

The hot months, November to March, are characterised by a north-easterly wind called the Harmattan which is far more violent in the northern tract.

Rain and wind are considered to be the main factors causing erosion. In spite of this, there is little damage in the south owing to the abundance of vegetation. The central tract, once well forested, has long since been cleared and burnt by farmers; erosion is going on everywhere, particularly on the Udi Plateau, which is being cut away by severe gullying. In this tract prolonged droughts, accompanied by fierce bush fires, are followed by torrential rainstorms.

But it is in the north that we see the most serious effects of disforestation. As compared with the south the following factors combine to cause more serious erosion :—

(*i*) A loose drift soil, and heavier grazing.
(*ii*) Fiercer bush fires, as a result of lower rainfall.
(*iii*) A stronger wind in the hot weather.
(*iv*) Although of short duration, more violent rainstorm than in the south.

Under these conditions erosion is continuously at work, the soil being subject to drift during the hot weather and sheet-erosion during the rains.

Discussing the question of desiccation, the author considers that the destruction of some 100,000 square miles of forest must have had some adverse effect on rainfall, but he remarks that a number of authorities are of opinion that desiccation in Nigeria is not a local affair but part of a "climatic retrogression on a continental scale." Be that as it may, there can be no doubt that disforestation is the direct cause of erosion in Nigeria and a number of facts are adduced to show that it is increasing.

Counter-erosion measures which are being undertaken in the north include the formation of plantation belts, and the reservation of 7,000 square miles of forest in which fire-protection is the most important feature. Complete protection is impossible and a technique called *early firing* has been evolved, which prevents large accumulations of dry material. Since this measure has been adopted a marked improvement in the quality and density of the forest growth has resulted.

Perhaps the most striking feature of the report is the important part wind can play as an erosion factor, and the case of Nigeria affords an interesting comparison with that of North America where damage of a similar, though more serious, nature is now being experienced.

A. P. F. HAMILTON.

THE SNAKES OF INDIA

BY LIEUT.-COLONEL K. G. GHARPUREY, I.M.S.

Published by the Popular Book Depot, Bombay 7, *Price Rs.* 3.

That some 20,000 persons die of snake bite every year in British India alone, and that this number represents a figure ten times the number of deaths from all other wild animals, coupled with the fact that people generally have varied superstitions and legends about snakes is a sufficient justification for a book like this which aims at giving general information and useful knowledge about common

snakes of India. Most of the deaths due to snake bite are due to fear as large number of snakes are not poisonous or they are so little poisonous that the poison injected is hardly enough to kill small animals. Only cobras, kraits and vipers are dangerously poisonous to man and this book is helpful in distinguishing the common snakes of India.

Several chapters are devoted to important poisonous snakes. Chapter 30 deals with the identification of snakes and Chapter 33 helps in determining whether a snake is poisonous or harmless. Chapter 31 deals with treatment of snake bites. The author does not believe in the various charms and potions commonly credited with qualities of counteracting the venom. In the case of poisonous snakes it takes a few hours before the poison proves deadly and it should be possible to remove the patient to the nearest hospital where antivenene treatment is available. There is however no antivenene available against the poison of kraits.

Interesting facts are recorded about all other kinds of snakes found in India and most of them are illustrated with half-tone plates. Out of nearly 300 kinds of land snakes found in India only 40 are poisonous and that is the reason why nearly 90 out of 100 persons bitten by snakes survive without any serious treatment. This is commonly attributed to the skill of snake doctors, charms, and stones.

The largest number of snake bites occur in the countryside where people work in the fields and it would be very useful if the book or its parts are published in the vernaculars of the provinces so that it can be available to the people in a handy form and at a reasonable price.

A. B.

EXTRACTS.

WORKING PLAN FOR BAHRAICH FOREST DIVISION, EASTERN CIRCLE, UNITED PROVINCES.

Summary of Prescriptions in Narrative Form.

The plan has been prepared for 15 years from 1936-37 to 1950-51 and is a revision of Mr. Stephens' plan for the period 1926-27 to 1935-36.

The *sal* forests have been formed into five separate working circles, while the remaining four working circles deal with the *jamun*, protection, grazing, and *khair* areas. In the 1926 working plan the formation of working circles was based principally on reserves, whereas in this plan it is more correctly based on types of forest.

The most noticeable feature of the main *sal* forests of Bahraich is the drought damage in Motipur which periodically causes severe losses of growing stock and prevents natural reproduction over large areas. This drought damage has necessitated the sub-division of the Motipur forests into four working circles instead of the single working circle to which they were allotted in the 1926 plan.

The working circles are as follows:—

(1) The Sal Selection Working Circle.

(Area=27,191 acres).

This consists of the *sal* forests of the Motipur, Chakia and Charda blocks in which drought damage is insignificant. Each block forms a separate felling series.

The silvicultural system is group selection. The rotation is not calculated, the exploitable diameter is fixed at 20″ in all three felling series, and the felling cycle is 15 years. The yield is regulated by the number of selection trees (20″ and over in diameter) permitted to be marked in fixed area coupes. With the object of guaranteeing a sustained yield of selection trees in perpetuity, by restricting fellings of such trees to the numbers which pass up from the next lower diameter class (16″—20″) during the felling cycle, the marking of selection trees is limited to Motipur—

Motipur felling series	50 per cent.
Chakia ,, ,, ...	90 per cent.
Charda ,, ,, ...	75 per cent.

of the selection trees existing in the area coupes at the time of marking.

The method of felling is to remove the full permissible percentage of selection trees, as far as possible to preserve the 16″—20″ diameter class for the future, and to tend younger crops adequately. Fifteen annual area coupes have been formed for each felling series separately, and after the main fellings subsidiary silvicultural operations will be carried out. During these operations particular attention will be paid to the treatment of young crops and *sal* will be definitely favoured against *asna*. Climbers are liable to do damage, and will be cut, while experiments in cutting them at different seasons will be carried out. Though the necessity for dry tree fellings is not anticipated special prescriptions are made to avoid overfelling, by a reduction in green tree fellings, if serious losses from drought occur. No artificial regeneration is prescribed, and the whole working circle will be fire protected and kept closed to grazing.

(2) *The Motipur Taungya Experimental Working Circle.*
(*Area*=3,070 *acres*).

This working circle corresponds to P. B. I. of the drought damaged *sal* forests of Motipur in which natural regeneration is, at present, impossible. The system of working is clear felling with artificial regeneration by *taungya*. As *taungya* is difficult here, and it is not yet known exactly how it will progress or what species can be successfully grown, the work will be largely experimental.

The rotation is theoretically 120 years but the conversion period approximately 90 years. The yield is by area, from 200 acres, which is the maximum which may be clear felled annually, provided the area so felled is immediately taken up for *taungya*. The method of felling is to work in three separate *taungya* centres and to distribute the fellings amongst them as follows:—

Ghumna centre	..	..	.. 50 acres p. a.
Mahbubnagar centre	..	..	.. 100 ,, ,,
Motipur centre	..	..	.. 50 ,, ,,

Suggestions are made regarding *taungya* technique and the choice of species to be sown. Subsidiary silvicultural operations will be carried out at intervals of 5 years in young crops raised by *taungya*, and climbers will be cut as is necessary. Prescriptions are made for special fellings of dry trees, if such occur in large numbers in areas which will not shortly be felled, and the whole working circle will be protected from fire and closed to grazing.

(3) *The Motipur Sal Improvement Working Circle.*
(*Area*= 15,578 *acres*).

This working circle consists of the remainder of the drought damaged *sal* forests of Motipur in which the stocking of *sal* is still moderately good, and corresponds to the unallotted P. Bs. belonging to the P. B. I. formed by the Motipur *taungya* experimental working circle.

The silvicultural system is modified selection. Dead and dying trees will be felled as they occur to count against a volume yield, the remainder of which will be removed in green tree fellings, while young crops will be adequately tended. As for P. B. I., (the previous working circle), the rotation is 120 years. The yield is by volume (9,554 volume units p. a.) based on total enumeration. The method of felling is to remove all saleable dry and top dry trees, the yield from which=Y1. The remainder of the yield (9,554—Y1 volume units) will be removed in green tree fellings. The order of fellings is suggested and subsidiary silvicultural operations will be carried out subsequently, where necessary, in all coupes.

The removal of overwood standing over teak plantations in compartments 24 and 27 is prescribed for, with certain restrictions, while compartment 40 will be planted up with teak at the rate of 30 acres p. a.

The whole working circle will be protected from fire and closed to grazing.

(4) *The Bhinga Taungya Working Circle.*
(*Area* = 16,787 *acres*).

This working circle consists of all the areas which can conveniently be closed to grazing in Bhinga block. These areas mostly contain poorly stocked overmature *sal* forests with a serious deficit of young reproduction.

The system is conversion to uniform, the regeneration area being clear felled and artificially regenerated by *taungya*. The rotation is not calculated, but is theoretically 120 years, while the conversion period is 70 years. The period is 30 years, P. B. I. being allotted and the remaining P. Bs. unallotted. The yield from P. B. I. is by area, from 200 acres of clear felling p. a. The method of felling is to work in three separate *taungya* centres and to distribute the fellings amongst them as follows :—

Kakardari centre	..	..	.. 108 acres p. a.
Ponsobbyganj ,,	..	..	.. 50 ,, ,,
Gandhi ,,	..	..	.. 42 ,, ,,

Suggestions are made regarding the further extension of *taungya* after 15 years, when this working plan expires.

Concerning *taungya* technique suggestions are made regarding the period of cultivation before sowing tree crops, the spacing of lines of tree species, stock maps, species to be sown, and removal of stumps from felling areas.

The removal of dead and dying trees in P. B. I. areas which will not come under clear felling for the next 15 years is prescribed for.

The yield from the unallotted P. Bs. is by area from 15 fixed annual coupes in which 50 per cent. of all overmature *sal* and *asna* trees (24" and over in diameter) will be removed in the first felling cycle. Healthy trees of the lower diameter classes will be retained for the future. These annual area coupes exclude compartments 1a, 33, and 38 which are already under *taungya*. Subsidiary silvicultural operations will be carried out in all coupes, subsequent to the main fellings, and tending of young crops raised by *taungya* is prescribed for.

Special prescriptions are made for the treatment of compartment 13b (728 acres) in which it is hoped considerably to accelerate the establishment of existing natural reproduction of *sal*.

The necessity for special fellings to remove dry trees is not anticipated as drought damage is negligible in Bhinga.

Most of the working circle is permanently closed to grazing, but certain P. B. I. areas are open to grazing at present. These will be closed to grazing when taken up for *taungya*, but will be re-opened as soon as possible. The whole working circle will be protected from fire.

(5) *The Bhinga Concession Working Circle.*

(*Area*=21,584 *acres*).

This working circle consists of the remainder of the Bhinga forests, except for a small overlapping *jamun* working circle, and the main object of management is the improvement of the grazing and of the supply of the concessionists' other requirements.

No definite system of management can yet be adopted, but the method of treatment adopted aims at the introduction of fodder grasses and fodder and timber species by means of *taungya*, the annual *taungya* coupe being limited to 200 acres. Clear felling and artificial regeneration by *taungya* may be carried out in any part of the working circle. Areas so treated will be termed P. B. I. while the remainder remains unallotted. The rotation is not calculated, and the conversion period will be 107 years if *taungya* proceeds at maximum possible speed.

The method of felling in P. B. I. is to clear fell 200 acres p. a. and regenerate that area by *taungya*, suggestions being made regarding the details of the *taungya* technique.

All areas not under *taungya* form the unallotted P. B. and the yield from these will be by area over 15 fixed annual area coupes, in which all *sal* of 24″ and over in diameter (overmature trees) will be felled, while all healthy trees of the lower diameter classes will be preserved for the future.

No subsidiary silvicultural operations will be required after the fellings, but are prescribed at intervals of 5 years in young crops raised by *taungya*. Lopping is not permitted except possibly in areas about to be clear felled for *taungya*. The whole working circle is open to grazing, though areas taken up for *taungya* may be closed for as long as is necessary, and is protected from fire.

(6) *The Bhinga Jamun Working Circle.*
(*Area*=599 *acres*).

This working circle contains all the workable *jamun* areas in the Bhinga block, and overlaps the two previous working circles.

The system is conversion to uniform. The conversion period is not calculated, but the rotation adopted is 30 years. The yield is by area from annual area coupes each of 25 acres. These coupes are smaller than normal for special reasons connected with an increase in the size of the working circle over that in the 1926 plan.

The method of felling is for the territorial staff to select each annual coupe of 25 acres and to clear fell it, except that seed-bearers may be retained where reproduction is scanty. Subsidiary silvicultural operations will be carried out immediately after the main fellings, and thinnings will be done in the young crops of previous coupes as is necessary.

As there is no need to close it the whole working circle will remain open to grazing, but will be protected from fire.

(7) *The Protection Working Circle.*

This working circle consists of remainder of the Bahraich forests which are closed to grazing, all of which are situated in the Motipur and Chakia blocks. Most of the circle contains a proportion of *sal* and *asna*.

The system is protection with improvement, the yield being by area from 15 fixed annual area coupes. Improvement fellings, cleanings, thinnings, and light selection fellings will be carried out according to the varying nature of the crops. Subsidiary silvicultural operations will be done during the main markings, to save expense. The necessity for special dry tree fellings is not anticipated, but if such are necessary, green fellings will be reduced accordingly.

The whole working circle will be protected from fire and closed to grazing.

(8) *The Grazing Working Circle.*
(*Area*=73,646 *acres*).

This working circle consists of the areas open to grazing in all blocks except Bhinga. It will be managed for grazing and no fellings are prescribed, though the exploitation of the species found in the working circle, which are at present unsaleable,

will be considered when any demand for them arises. No artificial regeneration is prescribed but experiments in it are permitted. The Babai block is protected from fire and the rest of the working circle is unprotected. The whole working circle is open to grazing.

(9) *The Khair Working Circle.*

This working circle contains all the exploitable *khair* forests in the division and overlaps other circles.

All *khair* trees will be exploited as they reach maturity. The rotation is not calculated, but the exploitable diameter is fixed at 12″. The yield will be by area from 15 fixed annual area coupes in which all *khair* of 12″ and over in diameter will be felled. All dead and dying trees will be removed, and congested even aged patches will be thinned.

Artificial regeneration at the rate of 50 acres p. a. is prescribed to supplement inadequate natural reproduction. Other regulations are as for the other working circles which this circle overlaps.

(10) *Miscellaneous Regulations.*

No new roads or bridges are required, but improved accommodation for the subordinate staff is suggested. No new fire lines are required. The divisional boundaries will be maintained and new sub-compartment boundaries will be cleared as required. Compartment histories will be maintained.

New 4″ maps are required when finances permit. Experimental and sample plots will be maintained. Petty fellings are permitted. Prescriptions are made for regulating the grant of concessions, and the supply of timber and minor produce is arranged for in the various blocks of forest. Fire records and the divisional note book will be maintained.

The treatment of cane brakes is prescribed, and three annual coupes have been formed, to be worked over in rotation.

No increase in staff is required at present, but improvement in the labour supply is desirable.

The usual control forms will be used and have been filled in to control the prescriptions of this plan.

A STUDY OF THE FOREST TYPES OF CHIR (*PINUS LONGIFOLIA*) IN HAZARA, N.-W. F. P.

Introduction.

Although Afghanistan is the extreme western limit of the chir in the Himalayas, chir forests of any importance do not occur beyond Hazara. Afghanistan and the tribal territory between Hazara and that country have had an unsettled history for centuries; they have seen a succession of races and civilizations commencing from the early Aryans who emigrated from the central Asian plateaux towards the Indian plains. The influence of man has thus peculiarly affected the natural forests in the north-west of India. From accounts gathered from people who know something

of the chir forests beyond Hazara it appears that fires and excessive browsing of goats have reduced the chir areas to a very poor condition. The forests between Kabul and Peshawar District contain only crops of chir poles. The chir areas of Dir, Swat and Amb States are also remarkably poor in mature trees and the general condition of the forests is stated to be open. Evidently a retrogression towards scrub forest is in progress. The major portion of the tract is however bare owing to the comparatively dry climate, (which allows fewer species to establish), and the pressure of the population on the forest for firewood, and the necessity of keeping the hill sides clear of any forest to prevent cover to the enemy.

2. Conditions in Hazara have been more settled in recent times and consequently chir forests of appreciable extent are first met with in this district. Of all the chir forests that have been under scientific management in India those of Hazara are situated in the extreme north-west. Their situation thus carries along with it certain climatic and other factors which differ markedly from those of other chir bearing areas towards the east. Monsoon rainfall being the most prominent factor of the Indian climate, presents a well marked decrease in precipitation along the Himalayas as one proceeds from east to west. There are other outstanding characteristics of the locality and it will be well to consider each of the ecological factors separately in order to follow easily the causes that have led to the evolution of the forest types as they exist in the Chir zone of Hazara to-day.

Ecological Factors of Hazara.

3. The most important ecological factors of Hazara are :—

(*a*) Rainfall.

(*b*) Topography.

(*c*) Geological Formation.

(*d*) Influence of man and animals.

It is well known that the ecological factors do not act on the vegetation of a country singly, but collectively and in a complex manner. The salient features of each can, however, be studied separately and their possible effect on the chir forests known.

(*a*) *Rainfall.*

4. Within the natural zone of chir the annual rainfall varies from about 35″ to 117″ but the best growth is met with in regions with a rainfall of 40″ or even less.(1) It is therefore of interest to consider how rainfall influences the chir forest. In this connection it is necessary to take into account the seasonal distribution of the annual rainfall as this influences the type of vegetation more than the total precipitation during the year. Three tables of rainfall are attached. Table I gives the average monthly rainfall at the different recording stations in or near the chir range in the Punjab. In Table II the average monthly rainfall is worked out for the four different chir localities in the Punjab and N.-W. F. P. This is done by averaging the recorded figures. Table III shows the seasonal rainfall in these localities with percentage of the total average annual precipitation in each season.

5. Entries in Table III begin from the "Rainy" season as it is during this season that the chir seedling commences its life and it will be convenient to follow the annual climatic cycle from the month of July.

6. Last column of Table II shows that the total rainfall of Kangra is almost double that of Murree-Kahuta and that there is also a gradual decrease towards Khanpur and Siran. It is more interesting however to compare the seasonal precipitations of these localities. One fact stands out boldly in Table III and that is the extraordinary amount of rainfall during the "Rainy" season in Kangra as compared with the other three localities. It is more than $2\frac{1}{2}$ times that of Murree-Kahuta and more than 4 times that of Siran. It can also be seen that Kangra gets a large proportion of its rain during the "Rainy" season. The three western localities can in fact be grouped together on this basis, in that all the three get markedly less rain in the "Rainy" season than Kangra. It will be seen that in the other three seasons the rainfall of the four localities does not differ so widely although a gradual decrease can be seen as we proceed to the west. On the other hand if the columns of percentages are compared it will be seen that the seasonal distribution of rainfall is more balanced in the last named three localities. This is mainly due to increased winter and summer rainfall as we proceed to the west. Table III also shows that autumn is the season of minimum rainfall and we all know that this is the danger period for the chir seedlings. Winter is the period of physiological rest for plants in the Himalayas and the precipitation during this period is not of immediate concern to the plants. Summer is another period of comparative drought, the effect of which on plant life is enhanced by the high temperatures during this season. Rainfall being the ultimate source of moisture for the plants which they absorb through the roots, while considering the effect of rainfall, the edaphic factors cannot be ignored. In favourable soil and on easy slopes, for instance, 16·99" of rain may be more useful for chir in Siran than 76·72" on shallow soil and for steep slopes in Kangra. Hazara has less rain in autumn than Murree-Kahuta and Kangra but the edaphic factors are strong enough to counterbalance the shortage in Siran. In Khanpur this is not the case and so the effects of the autumn drought are well marked.

(*b*) *Topography.*

7. Hazara has two Chir tracts, the Siran (with which is included Agror) and Khanpur. The chir forests of Siran and Agror occur on hills that rise upto 7,500 feet and border the Pakhli plains which is about 3,000 feet above mean sea-level. The slopes are all easy. Considerable area of the Pakhli plain is irrigated from the Siran River during the summer. This has the effect of raising the relative humidity in the tract during the summer months and so lessen the evaporation from the forest soil during the period of high temperatures. The gentle slopes are on the whole covered with a favourable depth of moisture retaining soil and as the rainfall is in a comparative sense more evenly distributed, the rapid run-off of rain water is not usual.

8. Chir is found on all aspects in the Siran and Agror areas.

9. Khanpur chir forests are however situated on steep ridges separated by long narrow valleys. They lie between 3,500 and 6,000 feet and occur almost exclusively on northern aspects. They join the Murree chir forests on the north-east below Tret and are separated from the Siran forests by cultivation that has extended right

TABLE I.

MONTHLY AVERAGE RAINFALL RECORDED AT DIFFERENT STATIONS.

Recording Station.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Palampur (A) ..	4·26	3·59	2·52	1·69	3·27	5·31	32·74	36·22	9·91	1·00	0·62	3·43	104·56
Dharamsala (A) ..	3·89	3·81	2·52	1·83	2·51	5·80	37·06	41·33	11·53	1·02	0·83	3·34	115·47
Kangra (A) ..	2·69	2·41	1·62	1·15	1·97	2·52	23·97	29·78	6·11	0·60	0·47	2·22	75·51
Murree (B) ..	2·96	6·03	4·84	3·69	3·56	3·49	11·43	15·27	7·74	1·73	0·29	2·27	63·30
Kahuta (B) ..	1·47	2·94	2·38	1·96	1·32	2·39	8·30	10·66	5·04	0·72	0·08	2·45	38·71
Haripur (C) ..	2·29	1·41	1·86	1·62	1·14	1·24	6·96	6·13	2·09	·44	·43	1·03	26·48
Manschra (C) ..	2·91	2·44	3·54	3·24	2·02	1·66	7·83	6·78	2·38	·88	·58	1·42	35·73

(A). *Vide* Revised Working Plan for Kangra, N. P. Mohan.
(B). *Vide* Revised Working Plan for Rawalpindi East division, H. M. Glover.
(C). Average from 1925 to 1934. Figures taken from District records, Abbottabad.

TABLE II.

MONTHLY AVERAGE RAINFALL FOR DIFFERENT FOREST LOCALITIES.

Locality.	January.	February.	March.	April.	May.	June.	July.	August.	September.	October.	November.	December.	Total.
Kangra chir forests. (Palampur, Dharamsala and Kangra average) ..	3·61	3·27	2·22	1·56	2·58	4·54	31·26	35·77	9·19	·37	·64	3·00	98·51
Murree and Kahuta forests. (Murree and Kahuta average)	2·21	4·48	3·61	2·82	2·44	2·94	9·86	12·96	6·39	1·22	·19	2·86	51·98
Khanpur forests. (Murree and Khanpur average)	2·62	3·72	3·35	2·65	2·35	2·36	9·19	10·70	4·91	1·08	·36	1·65	44·94
Siran and Agror forests (Mansehra) ..	2·91	2·44	3·54	3·24	2·02	1·66	7·83	6·78	2·38	·88	·58	1·42	35·73

TABLE III.

AVERAGE SEASONAL RAINFALL FOR DIFFERENT FOREST LOCALITIES.

Locality.	Rainy Season. July, August, September.		Autumn. October, November, December.		Winter. January, February, March.		Summer. April, May, June.	
	Total average rainfall.	% of annual rainfall.	Total average rainfall.	% of annual rainfall.	Total average rainfall.	% of annual rainfall.	Total average rainfall.	% of annual rainfall.
Kangra ..	76·22	77·33	4·51	4·6	9·10	9·3	8·68	8·8
Murree-Kahuta ..	29·21	56·2	4·27	8·3	10·30	19·8	8·20	15·7
Khanpur ..	24·80	55·2	3·09	6·9	9·69	21·5	7·36	16·4
Siran ..	16·99	47·4	2·88	8·3	8·89	24·8	6·92	19·5

through the chir belt to the blue pine zone for a distance of about 60 miles in a north-west direction Chir forests as such do not now exist in this gap but scattered trees are met with here and there in the village waste lands to show that there was once a continuous chir belt from Khanpur to Siran.

10. The main direction of the ridges in Khanpur is north-east to south-west. Haripur plain (1,700 feet) lies to the north-west. The ridges drop down to low hills and broken country towards Rawalpindi in the south-east. Near Taxila in the south-west all the ridges merge into the Panjkatha plain except the Margalla ridge which continues into Attock District for some distance. The Khanpur ridges join on the main Galis ridge in the north-east which lies in a transverse direction and has an average elevation of about 8,000 feet.

11. The configuration lends itself to the setting up of air currents during the summer which run up the valley from the plain towards the main Galis ridge. The general effect is great insolation on the southern aspects and this is marked by scrub forest, containing *sanatha,* olive and *phulai* being pushed up to an elevation of 5,000 feet, *e.g.*, Sataura (1). There are other contributing causes towards this movement of the scrub forests into the altitudinal zone of chir which will be discussed hereafter.

(*c*) *Geological Formation.*

12. The prevailing direction of the Himalayan ranges is east to west, or to be more exact north-west. This direction rapidly changes in Hazara. The ranges in Hazara and beyond the Indus run more or less in a north-south direction. This change of direction in the mountain ranges probably accounts for the lesser rainfall in Hazara and the country to the north-west. What is of more importance frcm the forest point of view is the underlying rock.

13. In Siran forests the underlying rock is gneiss. This is connected with the neiss of Baltistan and Ladakh through the Kagan valley. Its southern limits stretch across Hazara through Mansehra to above Amb on the Indus. There is a broad fringe of gneissose schists. There is a re-entering bay of tertiary rocks going up the Jhelum valley and extending beyond Muzaffarabad, into the Kunhar valley as far as Kagan (2). Within the chir zone in Siran the rocks met with are gneiss, gneissose schists and granitoid gneiss and to a less extent shales.

14. Gneiss and more particularly gneissose schists under the climatic factors present yield a soil peculiarly suitable for chir. It is fairly deep and remains moist for a long time after a fall of rain. Granitoid gneiss is found near the top of ridges. Its weathering is slower and big boulders are a ccmmon feature of the soil at such places. Soil is on the whole shallow but accumulations of fair depth occur in amongst the boulders.

15. Shales occur only in parts of Batrasi forests which is near the Kunhar river and the soil they produce is very shallow and generally unsuitable to chir. Outcrops of shales and granite, when they occur on southern aspects, at lower climates, *e.g.*, Batrasi, produce very shallow soils where chir refuses to reproduce. Major part of Batrasi forest lies in the Kunhar watershed and is not influenced by the humid conditions of the Pakhli plain.

16. The underlying rock in the Khanpur chir forests is close-grained, hard dolomitic limestone with occasional outcrops of shales and ferruginous sand-stones. Owing to the solubility of carbonate of lime in rain water the weathering of lime-stone produces only inappreciable quantities of soil as the major component of the rock is washed away in the form of solution. The weathered surface of the rock shows characteristic sharp jagged projections and is exceedingly rough and channelled with hollows and caves Bare sheets of rock or loose boulders of this description abound on the steep southern slopes and on the tops of well defined ridges and main spurs. Consequently the soil covering is very shallow and dry, subject to rapid variation of temperature or consists of a little clay or gravel mixed with lime-stone boulders. Where however the lime-stone alternates with other formations the weathering results in considerable quantities of mineral soil which accumulates in sufficient depth on gentler slopes and in depressions. On northern slopes where the shales outcrop more frequently the mineral soil is very much improved (3). It will be seen from the above description that the geological formation is a factor of great influence in Khanpur forests and combined with the configuration accentuates the adverse conditions for chir.

(*d*) *Influence of man and his domestic animals.*

17. The commonest effect of biotic factors and especially of human activity in its various forms is destructive and it tends in general to throw back succession to an earlier stage and also to modify it, replacing higher types of plant communities by lower ones. The usual forms of interference by man in the vegetation of a tract are :—

(*i*) Burning.
(*ii*) Felling.
(*iii*) Lopping.
(*iv*) Grazing and browsing.

We are all generally familiar with the effects of each of these activities. If practised over a number of centuries, they are sure to upset the progress to a natural climatic climax. Repeated burning will permanently oust the fire-sensitive species. The species most favoured for timber or firewood or agricultural implements will suffer a similar handicap. There are similarly a limited number of a species which will survive in a tract subjected to heavy grazing and browsing and persistent lopping. All the forests that we find to-day are the resultant of different ecological factors acting and interacting in a particular locality. In the case of Hazara the influence of biotic factors in the past is very pronounced. I may here give a quotation from the Upper Siran Working Plan :—

"The History of Hazara is very old. It lies within the area of a tract which 5,000 years ago was occupied by one of the earliest known human stocks, the Sumerians, of which traces have recently been found by the archæologists lower down on the Indus. Fifteen hundred years later came the Aryan invasions and the rise of Taxila to the existence of which, in the path of Alexander's conquests, we owe our first historical notice of the district. Since that date more than 2,000 years have passed. The period is dealt with in the *Gazetteer* history and the reader is necessarily impressed

by the almost certain evidence of the presence during the greater part of this period of thriving population in the drainage of the Siran or in its close proximity, that is, in the Pakhli, Rash and Agror plains.

18. There are chir forests (although of small extent) in Tanawal, which is the hilly country at the lower end of the Pakhli and Agror plains. It is therefore clear that both Pakhli and Agror plains were at one time under chir [or as will be shown later under a mixed forest of chir and oak (*Quercus incana*) with a great preponderance of the latter]. The early invaders began to clear the plains for cultivation and as the pressure for land increased subsequent generations went up to the blue pine zone towards Thandiani hills, thus creating a break in the chir belt alluded to above.

19. It may be of interest to know something about the life of the Sumerians referred to in the quotation given above. Wells says " They fertilised their fields by letting water run through irrigation trenches and they gradually became skilful hydraulic engineers ; they had cattle, asses, sheep and goats but no horses ; their collections of mud huts grew into towns." (5) One can naturally conclude from this that while in possession of the lands in Hazara they must have cleared a large portion of the forest for cultivation. " Some time about the time of Hammurabi (King of Babylon, B. C. 2100) or later a branch of the Aryan people who then occupied North Persia and Afghanistan pushed down the North-West Passes into India. They conquered their way until they prevailed over all the darker populations of North India and spread their rule or influence over the whole peninsula." (5)

20. Wells describes the life of the early Aryans in the following words : " They reckoned wealth by cows. They wandered, following pasture, and " trekking " their goods, as the South African Boers do, in waggons, though of course their waggons were much clumsier than any to be found in the world to-day. They probably ranged over wide areas. They were migratory but not in the strict sense of the word " nomadic ; " they moved in a slower, clumsier fashion than did the later, more specialized nomadic peoples. They were forest and park land people without horses. They were developing a migratory life out of the more settled " forest clearing " life of the earlier Neolithic period. Changes of climate, which were replacing forest by pasture and the accidental burning of forest by fire may have assisted this development. The grazing of primitive Aryan was far more important to him than his agriculture. At first he cultivated with a rough wooden hoe ; then after he had found out the use of cattle for draught purposes he began real ploughing with oxen using at first a suitably bent tree bough as his plough. His first cultivation before that came about must have been in the form of garden patches near the house buildings than of field. Most of the land which his tribe occupied was common land on which the cattle grazed together." " These Aryans were congregated not in cities but in districts of pasturage as class and tribal communities." (5) It is evident from these descriptions that the Aryans were a pastoral people who practically lived in the forests and whose interference with the natural processes in the forests was considerable.

21. Gresswell, in referring to the influence of the civilization of Taxila on the Galis forests, says :—

" That the tract dealt with lies along the path of the Aryan invasions of India which began circa 3,000 B. C. In close proximity to the Haro and within 50 miles of the ridge at Dungagali which forms the water shed was founded the succession of cities known as Taxila the civilization of which lasted for 2,000 years, *viz.*, from 1,500 B. C. to 500 A.D. Some idea of population may be gleaned from the fact that Alexander in 326 B.C. found Taxila a sufficiently important military obstacle to justify the conclusion of peace and cultivation of friendly relations, while Apollonius, 44 A.D., writes that Taxila was as large as Ninaveh. By all writers Taxila is described as a land flowing with milk and honey and irrigation is believed to have been practised. The country is now different, the Haro runs almost dry at certain seasons of the year while in the monsoon the villager calls down its banks to warn those below against the rush of the approaching torrent. These facts give good ground for the supposition that disforestation with loss of soil humidity began at very early times and that the Taxila Gujar, in meeting the demand for milk and ghi, was probably as adept in the use of fire as his successor of the present day." (6).

22. What is said above of the Haro basin would equally apply to the Siran and Agror areas because there can be no doubt that the people of those times would have devoted their attention first to forest with easier slopes as affording a better and more suitable grazing ground for their cattle.

23. That it does not always require centuries to completely change the vegetation of a tract can be demonstrated by quoting a couple of instances of recent times. Cleghorn travelled from Murree to Abbottabad along the main Gali ridge in 1862 and made a special mention of the abundance of fir and chir in the forests. In 1922 the Inspector-General of Forests travelled by the same route and wrote, "That the most striking features noticed during the tour was the large quantities of young blue pine which exist and are extending everywhere." (6) This disappearance of the chir from the Dungagali Range is traceable to fire protection. Another instance is that of Bhurban forest in Murree Range of Rawalpindi West division. B. O. Coventry says that when he first saw this forest in 1895 it was a fine climax formation of oak (*Q. dilatata*), the trees in the upper portion forming a closed canopy. Thirty years later he found it an almost pure forest of blue pine. It was the pressure for fodder from the surrounding villages and the consequently heavy lopping and grazing that had changed the whole aspect of this forest within this short period. (7).

24. Human interference in the forests of Hazara from earliest times has been described at some length because it is one of the most important factors in the evolution of the local forest types. Fire in the forests has been such a regular feature that it has had that regular and persistent effect which we usually associate with the natural factors.

Forest Types.

25. Having appreciated the different factors at work in the chir forests of Hazara it will be easy to understand the local forest types. It will have become obvious from what has been said above that there are many contrasting features in

the two tracts, the Siran and the Khanpur. The first two types are common to the two areas. The second type is not so well developed in Khanpur but occurs scattered in small areas. The last three are only found in Khanpur. The different forest types that can be distinguished in Hazara are the following:—

I. Chir-Kail-Oak Type.
II. Grass Types:—
 (*i*) Woodfordia sub-type.
 (*ii*) Indigofera sub-type.
III. Berberis-Myrsine-type.
IV. Carissa-Dodonaea-type.
V. Dodonaea-Woodfordia Type.

I. Chir-Kail-Oak Types.

26. This is a transition type and is found at an elevation of about 6,000 feet in Khanpur area and up to 6,500 feet in Siran where the chir meets the Kail zone. Blue pine is the aggressive species owing to the comparative protection from fire in recent times. Chir at these altitudes appears to have reached the limiting minimum of its temperature and was helped to capture the ground by frequent fires in the past. The species of oak in this type are *Quercus incana* in the Siran area and *Quercus incana, Quercus dilatata* and *Quercus glauca* in the Khanpur area. *Quercus dilatata* and *Quercus glauca* are mostly confined to the cool nalas where conditions are too wet for chir. *Quercus glauca* is found at lower elevations while *Quercus dilatata* extends up to the pure Blue Pine zone where it spreads out of the nalas. *Machilus* also forms close canopied glades of some extent along the nalas. It is however *Quercus incana* that plays an important role in the spread of blue pine in this type. The soil in this type is characterised by scattered big boulders. Were it not for the rich humus provided by the leaves of *Quercus incana* that collect on the upper side of the boulders and later on all over the place the young feeble seedling of blue pine would not hold its own against the hardy chir seedling. The number of flourishing blue pine seedlings that one sees under a big *Quercus incana* tree is really surprising if compared with an adjoining pure blue pine area. Leaving aside the nalas or similar extraordinary wet spots where close canopied dense thickets of *Parrotia jacquemontiana* are recorded in Khanpur area, the common shrubs are *Berberis* and *Lonicera quinquelocularis*. In this type *Quercus incana* trees should not be felled in any silvicultural fellings which for obvious reasons will be directed to the increase of blue pine and the fire protection should be thorough.

II. Grass Type.

27. To Grass Type must be assigned almost all the remaining chir forests of the Siran area. This is a well-developed type in this locality and ranges from Type I down to about 3,000 feet elevation. If the effect of the ecological factors enumerated above is kept in mind the evolution of this type will be obvious. A balanced rainfall, a steady and moderate humidity, and frequent fires have mainly contributed to the production of this type. The absence of shrubby growth of any importance is very remarkable. Under existing conditions it is a stable type and chir attains its highest quality of growth.

28. The associates of chir in this type are *Quercus incana*, *Machilus*, *Pistacia*, and *Alnus*. These are confined to the nalas but except in the case of Arbora forest in Agror where there is a close canopied crop of *Machilus* all along a nala running through the chir forest these trees occur singly or in small groups. *Machilus* is not lopped for fodder. *Pistacia integerrima* and *Alnus nitida* occur at lower elevations while *Quercus incana* and *Machilus* comparatively higher.

29. The distribution of *Quercus incana* in this type is somewhat peculiar and leads one to certain conclusions. Under Type I it has been stated that it occurs in a higher zone. It descends through the chir zone proper along the nalas and can form pure forest of noticeable extent at about 4,000 feet elevation. Considering the prevailing climatic and favourable soil conditions one would conclude that the whole of the chir zone was suitable for the establishment of a forest of *Quercus incana*. The oak forest alluded to above is a Guzara (village forest) below Shamdhara forest (which is pure chir) in Agror, just opposite Shamdhara village. It is badly lopped but as ascertained by personal enquiries has been immune from fire for many years. Oak trees growing in Ziarats and graveyards about this elevation are of a big size and appear to thrive well. It is therefore apparent that the whole of the chir zone in Siran is eminently suitable for *Quercus incana* and in fact a forest of this species is the climatic climax for this locality.

30. It is the repeated firing of the forest from very early times and later on reckless lopping of oak that has almost exterminated it and favoured the complete sway of chir. We have therefore to keep in mind the great importance of fire in keeping down the forest in this area to the chir sub-climax.

31. The quality of chir forests in Siran approaches very nearly that of the Tons Valley in Tehri-Garhwal (the best chir forests in India). They fall in F. R. I. Quality I. This appears to be due to a very suitable adjustment of the fire factor with the generally mesophytic resultant of the other factors.

32. Some of the broadleafed species like *Casearia tomentosa*, *Pieris ovalifolia* and *Rhododendron arboreum* which are the common associate of chir in other localities are here reduced to very insignificant bushes and are rare. Rhododendron which is found only along the nalas in one forest (Dadar compartment 2) is not abundant. The height of the plants is not more than 8 feet ; *Casearia* and *Pieris* which are found in all areas subject to fires are never higher than 6 feet and are scarce.

33. Grasses form almost wholly the undergrowth in chir forests of Siran wherever the canopy is opened. A close canopied forest has no undergrowth. When a regeneration felling causes a heavy break in the canopy the ground is opened to chir seed as well as to other species which can establish under the given conditions. A shallow rooted plant such as grass requires frequent though not necessarily heavy precipitation and if long periods of drought occur, they involve the dying down of the grass until the rainy season again comes round. It is also known that grass is not killed by the ground fires common in chir forests. Taking into consideration the information given under ecological factors it can be seen how admirably grass is suited to the prevailing conditions. The lower monsoon rainfall itself rules out many tree and shrub species which originate or flourish in a heavy monsoon climate.

It thus happens that grasses and chir are ready and begin to take possession of the area opened out in regeneration fellings almost simultaneously. In actual experience things are not so optimistic and grasses in many instances have taken the lead and covered the area before chir seeedlings have had a chance to establish. This in no way handicaps the chir which is liable to germinate in thick growth of grass and the young chir seedlings appear to stand the moderate shade of grass quite well. The common species of grasses are *Iseilma laxum* (*chhat*) *Hetropogon contortus* (*sariala*) *Andropogon* spp. (*pilwan*) *Imperata* spp. (*sheru*). The last named grass has been described as detrimental to chir regeneration in other localities but in Siran it does not appear to cause any difficulty. It is confined to comparatively wet places. Chir completely suppresses the heaviest growth of grass in about 5 years.

34. It has been stated by many forest officers that grazing is beneficial for chir regeneration. This is true in this sense that grazing would keep down the grass and would do no harm to the young chir seedlings. Light grazing has been suggested as the via media to meet both ends. In practice it is impossible to draw the line between light and heavy grazing. When cattle are let into an area it will be observed that either the grass is grazed down to the level we want it to be and the chir seedlings (especially the yearlings) are trampled down and killed to the extent we do not at all like, or, the grazing has not had enough effect in reducing the growth of grass. Grazing no doubt is the only possible remedy to reduce the growth of grass, as fire, the other useful servant of the forester is out of question in an area beginning to regenerate. It is suggested that regeneration areas be closed to grazing in alternate years. A two years old chir seedling does not suffer so much from the effects of grazing and the grass will not attain that luxuriant growth which it would otherwise attain.

35. It is natural that other species which take longer to establish will try to find a place in the regeneration areas along with chir and grasses. The only other species that do find a place on a noticeable scale are:—

(*a*) Rubus ellipticus.
(*b*) Rubus lasiocarpus.
(*c*) Woodfordia floribunda.
(*d*) Zizyphus oxyphylla.
(*e*) Indigofera gerardiana.
(*f*) Indigofera pulchella.
(*g*) Inula cappa.

The last named, *i.e.*, *Inula cappa* is a herb with a thick root stock. It is common all over the chir zone and has marvellous powers of shade bearing and fire resistance. In chir areas subjected to annual firing this is almost the only plant seen. It is able to seed every year inspite of fires.

Rubus spp. do not form dense thickets but appear scattered over hot aspects with fairly deep soil.

Indigofera, *Woodfordia* and *Zizyphus* take possession of particular localities and give rise to distinct sub-types which are described below:—

Indigofera Sub-type.

36. *Indigofera gerardiana* at elevations above 4,500′ and *Indigofera pulchella* at lower elevations, take possession of land that is subjected to heavy grazing. Both

are light demanding species and adapted to colonizing new clearings. Growth is however very slow as compared with chir. In areas of particularly easy slope where cattle are likely to concentrate for grazing the grass is over-grazed and *Indigofera* being untouched even by browsers spreads over the area. Chir is kept back by trampling but comes up through *Indigofera* bushes, and if grazing is stopped, completely suppresses the *Indigofera*. *Indigofera* Type occurs only on cooler aspects. Where *Indigofera pulchella* is found mixed with *Woodfordia* it may be taken as an indication of improvement of the ecological factors ultimately suitable for chir.

Woodfordia Zizyphus Sub-type.

37. This sub-type occurs at about 3,000′ on southern aspects. *Woodfordia* particularly is a shrub that will grow on almost bare rock with high soil temperature in the summer. *Zizyphus oxyphylla* is its associate but this shrub keeps to places where there is a slight accumulation of soil but conditions of insolation are otherwise extreme. Soil in this sub-type is either bare rock or shallow soil with a mixture of sharp-edged gravel. Grasses are scarce, which is probably the result of fires and grazing. It is common to see *Woodfordia* type on the southern aspect and *Indigofera* type on the northern aspect of a spur. With closure to grazing the *Indigofera* appears to move into *Woodfordia* along with grasses. Strict closure to grazing and protection from fire would considerably improve the *Woodfordia* sub-type although it will remain a permanent feature on steep stony southern slopes.

III. Berberis Myrsine Type.

38. This type and types IV and V are found exclusively in Khanpur forests. There is no trace of Myrsine, Carissa or Dodonaea in Siran forests. Stunted specimens of Myrsine have been seen in rather stony ground at elevations of about 5,000′ in Agror forests but this shrub is extremely rare in the Grass Type. As it is ordinarily found at elevations of 4,000′ to 5,000′ in Murree forests, and the places it occupies in Khanpur are below the Chir-Kail-Oak Type of forests, it may be taken as an indicator of moisture and temperature conditions midway between those of this type and those indicated by Dodonaea. How it has completely disappeared from the Grass Type of Siran cannot easily be ascertained. The types of Khanpur tract owing to the generally rugged nature of the ground and sharp contrasts of aspect cannot be arranged in an exact altitudinal zonation. The forest is itself much cut up by cultivation and a compartment situated higher than the next lower one may be under the strong influences of aspect and soil factors which may tend to discount all the advantage it gains by higher elevation. In general it may be said that the Berberis Myrsine Type occurs on cooler situations with a reasonable depth of soil and represents generally the best quality of chir forest for this locality, which does not approach even the II quality of Siran. The Grass Type of Siran wherever it is found in Khanpur carries always a few scattered Berberis Myrsine in it. It seems as if the Grass Type is being invaded by the Berberis Myrsine Type but this side of the question has not been studied in detail as yet.

39. The associates of chir in this type are *Quercus incana*, *Cornus macrophylla*, *Ficus palmeta*, and *Olea cuspidata*. *Olea* is found at lower elevations usually on spurs facing south.

IV. Carissa Dodonaea Type.

40. This type and the next one, *i.e.*, Dodonaea—Woodfordia are found generally speaking at a lower elevation, 3,200′ to 3,800′ and are essentially the types met with in places where the chir comes in contact with the brushwood forest. The proportion of Dodonaea is always larger. The associates of chir in this type are *Olea cuspidata, Bauhina variegata, Grewea oppositifolia, Mallotus philipinensis, Celtus australis* and *Casearia tomentosa.* This is the type which has occupied the areas that had suffered greater deterioration from fires in the past than those now occupied by Berberis Myrsine Type. The soil is shallow and the growth of chir poor but this type definitely denotes an area from which chir was ousted by repeated fires in the past and is now taking possession again. The successful regeneration of chir is governed by the depth of soil that appears to be increasing in areas saved from summer fires.

V. Dodonaea Woodfordia Type.

41. This is somewhat similar to the Woodfordia Sub-Type of Siran. This type occurs on southern slopes. The chir trees that occur are scattered and very stunted. This type goes up to 5,000′ and represents the extreme insolation conditions which prevail on southern slopes; Woodfordia occupies bare rock and Dodonaea stony ground. *Zizyphus oxyphylla* is also present. This type under the conditions prevailing in Khanpur appears to be definitely unsuitable for chir. The chir trees that do exist may be considered as stragglers from a nearby chir area with more suitable aspect and generally better edaphic conditions. The only hope of making these areas fit for chir appears to be complete protection from summer fires and grazing, but both are impossible to achieve, judging from efforts in the recent past.

Conclusion.

In this study of the forest types of chir in Hazara an effort has been made to trace their evolution from the earliest times of which information is available. The Grass Type which is peculiar to Siran has been described in some detail and the important rôle that human interference has played and is still playing has been pointed out. The high quality of chir attained in this type has been traced to the climatic and edaphic factors at work. The supreme importance of aspect and configuration is well illustrated in Khanpur forests. The inter-relation of the different types in Khanpur requires further detailed study. The complexity of the problem may be judged from the fact that Berberis Myrsine type which may broadly be put as the highest stage in the succession series in Khanpur occurs in some instances within a very short distance of the brushwood type represented by *Dodonaea* and *Acacia modesta,* a xerophytic type low down in the scale.

This paper is a preliminary effort to study the Hazara chir forests from the ecological point of view. It has, therefore, been considered risky and premature at this stage to give dogmatic generalisation about the different silvicultural operations particularly for the Khanpur area.

BASHIR AHMED,
E. A. C. Forests,

REFERENCES.

1. Silviculture of India Tree.—R. S. Troup.
2. Sketch of the Geology of Punjab.—H. B. Medlicott.
3. Working Plan of Khanpur Range Forests.—Mehr Chand.
4. Working Plan of Upper Siran Forests.—E. A. Gresswell.
5. Outline of History.—H. G. Wells.
6. Working Plan of the Gallis Forests.—E. A. Gresswell.
7. Indian Forest Records, Vol. XIV, Part II.—
Denudation of the Punjab Hills.—B. O. Coventry.

PHILIPPINE ISLANDS FOREST WEALTH

Extracts from a speech made by Mr. E. Rodriguez, Secretary of the Department of Agriculture and Commerce, to the Students of the School of Forestry, University of the Philippines, on 23rd March 1935.

You gentlemen who graduate to-day are to shoulder the task of caring for the vast forest resources of our country covering 21,000,000 hectares and with a potential value of P. 800,000,000 richer than the forest wealth of any of our Oriental neighbours and surpassed by those of only a few other countries of the world.....

The forest provides agriculture with a permanent supply of wood and water without which it cannot exist. Forestry and irrigation go hand in hand in the agricultural development of any country.....The forest, thus, either as a living and growing thing or as converted into a commercial product, is eminently useful to agriculture.

In the industrial pursuits, the products of the forest are just as indispensable. Without forestry the permanent prosperity of the industries is impossible because it depends upon a permanent supply of wood and water which only the forest can provide. The demand for wood that is needed in the construction of industrial plants, of ships, and of edifices, is increasing because more and more of them are being built in this great industrial age in which we live. . . In the matter of transportation, forestry is an indispensable factor. The raw products of the farms must be brought to the factory to be made into finished products. Transportation connects the farm and the factory. The railroad system of any community is dependent upon wood. Without a permanent supply of wood and water railroad transportation would be next to impossible. The forest provides the wood needed for ties, poles, and cars.....

The forest resources of the world are so vast that cutting with no thought of destroying has been indulged in from time immemorial.....

In most countries, the question is no longer one of conservation, for with the exception of America, Russia, and a few tropical countries, there remain few natural forests to conserve. Even in the United States, timber is cut three times as fast as the trees can grow, for the need of conservation has been recognised only recently in that country.

In the Philippines our forest wealth is one of our most extensive natural resources.....

In the case of the forests, it is in our hands to improve or impair them, to kill them, or to make them live. This is why the problem of forestry is mainly one of conservation....It is lamentable indeed that at present there is no proper provision for the conservation of this wealth. We only have about 500 men to guard this vast area. For every 42,000 hectares of our forest, we have only one to care and protect it. In Java, there is one man for 1,270 hectares. In the Federated Malay States, they have one for every 5,000 hectares. In Japan, there is one man for every 5,000 hectares.....

It was with a view to conserve this forest wealth of ours that, upon the insistence of the Dean of your school, Mr. Fischer, who is at the same time the Director of Forestry, and upon my insistence as head of the Department of Agriculture and Commerce, that the Philippine Legislature passed a bill last session appropriating the sum of *P.* 100,000 to be spent for the reforestation of our country. It is to be regretted that for the sake of economy, which is one of our greatest needs to-day, the Governor-General was forced to veto this bill.....

The need is more men, and I am glad that we have a school in which young men are given the proper technical training for this important task. In so far as I am concerned, I am going to exert every effort to have the Legislature re-enact the bill which it passed last session appropriating the sum of *P.* 100,000 for this purpose and bring pressure upon the chief executive to convert it into law by his signature.....

Last year, the Bureau of Forestry despite the fact that it was handicapped as it has always been by insufficient appropriation and lack of men, was also able to make a total collection of *P.* 1,670,000 from the various uses of our forests and their products. Last year's appropriation of the Bureau was *P.* 611,000. The administration of our forests, therefore, brought in last year a net income of *P.* 1,060,000 to the Government. Large as this amount is, it is only 60 per cent. of the income that could be derived every year, taking last year as a basis, were the Bureau of Forestry granted more funds and men.

INDIAN FORESTER

FEBRUARY, 1936

A TRANS-FRONTIER TOUR IN THE NAGA HILLS

BY N. L. BOR, I.F.S.

The following account of a short tour which I undertook in March 1935 may be of interest to readers of the *Indian Forester*, inasmuch as it gives some account of an area about which nothing is known botanically.

The meeting place was at Laruri on the Tizu or Nantaleik river which forms the eastern boundary of the Naga Hills district at this point. The party consisted of Dr. J. H. Hutton, D.C., Naga Hills, Capt. B. S. Hartland, Commanding the escort of 50 rifles, Capt. Kingdon-Ward, the explorer-botanist, and myself, not to mention a white bull-terrier bitch and a brown spaniel.

Laruri is an interesting village. The inhabitants have a rather gruesome method of dealing with their dead. They keep the corpse inside the house in a boat-shaped coffin (with a hole below to let the juice out) for a year, after which the bones are taken out and kept in large earthen-ware pots in the granaries.

The women are tattooed with a diamond-shaped pattern on the legs. We saw the operation being performed in Laruri amid tears and lamentation. The instrument used was shaped like a tooth-brush with sharp thorns in the place of bristles. This was held over the line to be tattooed and given a sharp tap with a mallet which drove the thorns well into the flesh and the dye is rubbed in later. The girl's legs were a fearful sight and the operation must be a very painful one.

1*st day*.—The Tizu river, 1,600′, was crossed by a cane bridge, very rickety in places, upon which only a few people could venture at one time. Hutton's spaniel, Nina, caused a dislocation of the traffic by getting her hind-quarters down in a gap in the floor boards and

staying put, looking unutterably miserable, until she was hauled out by the scruff of the neck and carried over.

The geological formation hereabouts is mainly a slaty shale which weathers to a very dry soil but conglomerate is seen here and there. The vegetation is typical of the Tizu valley; grassy slopes with a small number of species, all of which favour dry soil conditions. The species include *Columbia floribunda*, *Wrightia tomentosa*, *Bauhinia variegata*, *Phyllanthus emblica*, *Holarrhena antidysenterica* *Rhododendron arboreum*, *Grewia asiatiaca*, *Kydia calycina*, *Quercus serrata* and *Q. fenestrata*, *Engelhardtia* sp. and a few others. A cycad, and a stemless *Phoenix*, probably *P. acaulis*, were seen, the latter quite common in places. The interior of the stem of this plant makes quite good eating I am told.

Eupatorium odoratum covered large areas, and other shrubs seen were *Woodforida floribunda* and a leguminous plant with pretty purple white flowers.

Clumps of pine were encountered at 2,500′. This pine, *P. khasya*, grows in open stand with a grassy undergrowth and must be very old. Curiously enough only old trees and seedlings of one or two years were seen; there were no young trees. This state of affairs is probably explained by the fact that fires run through these grassy slopes annually and kill out everything except the ancient trees which are protected by their thick bark. Many of these old trees are dying.

Grasses of many species were noticed in the undergrowth; they include *Erianthus fulvus*, *E. longisetosus*, *Andropogon assimilis*, *A. nardus*, *A. contortus*, *Arundinella clarkei*, *Pogonatherum saccharoideum*, *Pollinia* sp., *Agrostis* sp., all of which had dried up to a tinder-like state.

After an easy march of 5 or 6 miles rising all the time Nimi was reached at 4,000′. This village is situated on a little spur of slate which drops away steeply on three sides. Above the village the defences consist of an impenetrable mass of prickly pear (*Opuntia* sp.) and the creeper *Cæsalpinia sepiaria*. The other three sides are protected by a fence of bamboo from which projects a triple row of the most

A southern Sangtam with crossbow and spear.

Choemi Village.

formidable looking *panjis*. Inside this fence is another bamboo fence also decorated with *panjis*.

The village can only be approached from below, up steps of slate shale which have been burnished by the feet of generations of inhabitants, to a wooden door garnished with *panjis*, which leads into a recess for a sentry and finally into the village through another door.

The walls of the houses are made of coarse bamboo matting, though some were seen which were built up of thick slabs of slate. The roofs of the houses were covered with thin slates, a circumstance from which the tribe takes its name, Kalyo-Kengyu, literally "the people who live in slate-roofed houses."

The houses are miserably small and dark and reek of wood smoke which can only escape at the eaves or by chinks in the roof. The slate roof does not seem to be a very efficient protection against the rain as the slates fit badly and there are many gaps; the same remark applies to its efficacy as a chimney. The ridge is thatched with the leaves of *Imperata arundinacea*. The houses are huddled together and the walls almost touch owing to the restrictions imposed by the smallness of the site.

The Kalyo-Kengyu are men of small stature who do their hair in the usual Naga fashion. Every male carries a spear and *dao*, and very often a cross-bow in addition, when he leaves the sanctuary of the village. The women are tattooed and distort the lobe of the ear by inserting into it a disc of wood sometimes as much as 3″ in diameter.

The village is at war with Chimi, another village situated on the far slopes of the next large spur to the north. Social relations are confined to raiding one anothers' fields, "shortening" any unfortunate cultivator found and decamping with the head. Honours at present are about even. Last rains Chimi raided Nimi's fields and killed three women. They were attacked by the Nimi bucks just as they were about to make off with their bag of heads, lost one killed, and were obliged to leave two Nimi heads behind.

The head of the Chimi man, minus the lower jaw, now ornaments the top of a stem of *Dendrocalamus sikkimensis* erected in the centre

of the village. Close by is a house with a row of seven old skulls just above the door.

This village excels in pottery which is made from a very fine textured clay found in the neighbourhood. Their tobacco pipes are made from the same material and often three separate bowls jointed on to one stem may be seen. A shoot of *Arundinaria* sp. joined to the stem serves as a mouthpiece.

Camp was pitched at 4,500′, on an old camp site cleared many years ago by the Makware expedition.

2nd day.—Our path led from the village through abandoned cultivation to a river at 3,500′. The vegetation was scrubby, *Quercus griffithii* and *Q. fenestrata* were prominent with shrubby species such as *Maesa chisia, Caryopteris wallichiana, Artemisia vulgaris, Laggera alata, Dobinea nepalensis, Saurauja nepalensis* and *S. punduana, Inula cappa* and *Osyris arborea*.

From the river the path rose steeply to 5,000′ mainly through an open forest of *Pinus khasya*, with *Quercus serrata, Q. griffithii, Pieris ovalifolia, Vernonia arborea* and *Rhododendron arboreum* as underwood, the latter in magnificent bloom. Here *Pinus khasya* grows to magnificent proportions and trees 80′ tall with a girth of 9′ are by no means uncommon. As is usual in this area the undergrowth is mainly grass, tinder dry at this time of the year. In fact most of it had already burned and *Gerbera piloselloides* were just emerging from the ashes.

Reaching 5,000′ the path proceeds along the face of a very steep slope with occasional ups and downs. A stream of excellent water was crossed at this elevation and camp was built just above it in an evergreen forest of *Quercus spicata* with lauraceous species. Just below camp was a leafless *Strobilanthes* in fruit with a broadly winged stem, which appears to be *S. pterygorrhachis*, first discovered by C. B. Clarke on Japvo near Kohima in 1885. The palm *Caryota urens* was very common in the vicinity as well as species of *Musa*. The undergrowth in this forest was mainly *Elatostemma, Ardisia* and *Chloranthus* spp.

This march was without incident except that Kingdon-Ward, more intent on the identification of a tree overhead than in the path upon which he was walking, took a header down the *khud*, fortunately without untoward results. He was luckier than I was some years ago in the Balipara Frontier Tract, when out walking, plant gazing as usual, I stepped off the path and fell 8′ into a bed of *Girardinia heterophylla* ; a lightning identification in more senses than one.

I suppose all botanists come to this at one time or another if one is to judge by that delightful picture which appeared in *Punch* some years ago. It depicts a botanist who has fallen over a cliff and is grasping a shrub which has arrested his downward flight. The distracted face of his wife peers over the edge of the cliff and she cries to him "Are you alright, dear ? What are you holding on to ?" The botanist, scientific to the last, replies "I am not quite sure, dear. If it is not *Bombus furiosus*, it is some closely related species."

3rd day.—From the camp the path rose 2,000′ to the pass over the main Sarameti ridge, and leads to the village of Kuladoree, an offshoot of Nimi, on the Burma side.

At this elevation, 7,500′, the forest is evergreen and consists of *Quercus lamellosa*, *Q. xylocarpa*, *Q. spicata*, *Schima wallichii*, *Castanopsis tribuloides*, *Magnolia pterocarpa* and other Magnoliaceae, and occasionally *Bucklandia populnea*. The undergrowth consists mainly of such shrubs as *Lasianthus biermanni*, *Daphne involucrata*, species of *Ilex*, *Euonymus*, *Viburnum* and a 6′ tall *Strobilanthes* which was not in flower. The latter shrub covers large stretches.

Patches of a small *Arundinaria* with spiny nodes were met with here and there and the path was strewn with bright yellow corollas fallen from a epithytic *Agapetes*. The trees were swathed in moss and long streamers of moss hung from the branches. Seated in moss on the trunks of the trees was a pretty orchid (*Pleione* sp.) with snow white sepals and petals, and a large lip streaked with purple or orange. This orange colour appears with age and the young flowers do not show it.

Surprisingly enough in this evergreen forest large stems of *Pinus khasya* were met with but only occasionally. Another conifer seen was *Cephalotaxus griffithii*.

On the Burma side which gets more sun, as the ridge runs roughly north-east and south-west, *Rhododendron arboreum* was common growing gregariously. *Betula utilis*, *Bucklandia populnea* and *Quercus* sp. were other trees seen. *Psychotria calocarpa* was common in the undergrowth in masses. *Chrysosplenium nepalense* covered depressions in the forest floor which carry water during the rains.

The main difficulty of camping on any of these ranges at this time of the year is the lack of water. There was no water on the ridge, but our coolies were successful in finding a supply some distance down the hill and water was carried from there up to camp on the ridge at 7,500′.

Unfortunately the day was very misty and we could not determine how far we were from Sarameti, a peak 12,500′ high on the Assam-Burma frontier. Kingdon-Ward and I much wanted to examine the vegetation on this mountain seeing that it is the highest for many miles in any direction. We felt that it must contain much that would be new to science.

In the afternoon we reconnoitred three miles or so up the ridge. At first a path had to be cut through 6′ tall *Strobilanthes* but after a while we struck an animal track which led in the right direction. Up to 8,000′ the forest exhibited no change but from 8,000′—9,500′ there is a distinct alteration in the flora. This is partly due to altitude but also to the very thin soil cap and steep slopes. The trees were at the most 20′ tall and consisted mainly of *Quercus spicata* var. *typica*, *Rhododendron arboreum*, *Heptapleurum hypoleucum*, *Gamblea ciliata*, *Viburnum coriaceum* and *Prunus nepalensis*. *Edgworthia gardneri* with furry balls of sweet smelling yellow flowers was just coming into bloom though still leafless. An epiphytic rhododendron, *R. vaccinioides*, was also in flower. A species of aconite was common on a knife-edged ridge, but we only found withered stems though the capsules still contained seed.

Hartland climbed to 9,500′ but did not get a clear view of the summit owing to cloud. He was of the opinion, however, that Sarameti was still a considerable distance away to the north.

This was bad news seeing that we had only one day in hand in which to make an attempt to get to the summit.

On the way back to camp I noticed a specimen of *Hymenopogon parasiticum* in fruit. The whole plant was in violent agitation and closer observation showed that this was due to the breeze having set the foliaceous sepal in motion. This sepal was flapping rapidly to and fro, shaking out a stream of seeds from the dried capsules whence they were carried to a distance by the wind. This obviously is the purpose of this sepal and it is a pretty efficient means of seed dispersal. It makes one wonder what is the object of the foliaceous sepal of *Mussænda*, another genus of the same family, which does not act as a fan but dries up and falls as the capsules ripen. The sepal of *Hymenopogon* does wither but the veins remain to give it strength and lightness.

The trees on the ridge carry an immense weight of epiphytes, moss, orchids, ferns and many species of Vacciniaceæ and Gesneraceæ.

4th day.—Starting early Hartland and Kingdon-Ward made for the summit while Hutton and I tried to climb the 10,300′ point south of the mountain. The former made good progress and reached snow somewhere about 11,000′, but at 2 P.M. seeing that the summit was too far away to allow them to get there and back before dark, they wisely decided to return. Snow was a novelty to the Nagas with them and one of them brought back a tin box full of it. Much to his disappointment it had all melted by next day.

From 9,500′ upwards rhododendrons increased in numbers and the most magnificent of them all was *R. maccabeanum* just coming into flower. The inflorescence consists of a tight ball of the most gorgeous orange flowers at the tip of a branch clothed with ovate pendulous leaves, glossy olive green above and the under surface covered with a dirty grey tomentum. Other rhododendrons identified by Kingdon-Ward were *R. elliotti* and *R. maddeni*. Trees seen included *Quercus spicata, Betula cylindrostachys, Litsaea sericea, viburnum coriaceum*,

and *Juniperus recurva*, the latter a new record for Assam. The undergrowth is sparse and consisted mainly of the fern *Lomaria glauca* and a shrubby growth of *Arundinaria*.

In open grassy spaces *Hemiphragma heterophyllum*, *Gerbera piloselloides* and a gentian were seen. *Gaultheria* sp. was also gregarious in such places. *Daphne papyracea* was very common and a magnificent sight in full bloom. Other common shrubs were *Berberis wallichiana* and *Myrsine capitellata*.

Mithun appear to be numerous and their tracks were often seen as well as the droppings of tiger and serow. Bird life was conspicuously absent.

On the way back to camp the village of Kulādorre, 4,000′ below, was examined through glasses. The village consists of about 10 houses surrounded with a formidable looking stockade furnished with what appeared to be a drop gate. The granaries are all outside the fence. I should imagine a small village like this finds life rather sticky when the head taking season comes round.

From what we saw of it the flora of Sarameti is surprisingly disappointing and very much resembles that found on Japvo, 10,000′, near Kohima, Naga Hills. Of course, we were rather early for flowers and a visit later on in the year, say in May, would be worth making. The collections are not worked out yet but of a parcel of five mosses, one turned out to be a new species and one a new genus.

5th day.—Leaving camp at 7,500′ we retraced our steps towards Nimi but turned away to the north when some three miles from that village—Kingdon-Ward left us and went straight on to Nimi and from there to Laruri. He intended to go on into Burma and return *via* Manipur. We were sorry to see him go.

The path rose and fell in its usual monotonous fashion over grassy slopes with occasional pine, oak, rhododendron and *Pieris ovalifolia*. After traversing a particularly nasty looking cliff, camp was pitched on the site of an old *jhum* at 5,800′.

6th day.—From camp the path ascended steeply to the Kamku ridge which was crossed at 6,800′, then followed a long descent to a river where we had lunch. Lunch over, we toiled up a 2,000′ slope

and found camp prepared for us by the Sema village of Purotomi in a delightful grassy glade with pine trees scattered about. After our long hot march I was all for dallying peacefully among the tea cups but this had to wait until we had visited the Temoru, a Yimstungr village some 3 miles away and 700′ higher.

The land about Temoru was all *jhumed* wherever possible and there were few trees to be seen. Pine, *Quercus semiserrata* and *Schima wallichii* (or it may have been *S. khasiana* from the size of the capsules) were about all that were seen. Close to Temoru *Viola patrinii* covering square yards of ground was a remarkable sight.

The village is a collection of miserable looking hovels. The lower khel was surrounded by a bamboo fence but as it was broken in many places, the defences may be said to be nil. The upper khel is on a knife-edged ridge and is entered by a gate over which a sentry perches.

From the upper khel a magnificent view of Sarameti could be obtained. The ascent from the south up to the ridge seems to be perfectly easy. The western face is precipitous. Seen through glasses it looks as if scrubby vegetation extends up as far as 11,000′.

7th day.—An up and down march as usual brought us to the Yachum village of Rangkyo or Mukotirre at 5,000′. It had been growing warmer these last few days and when we arrived in camp the thermometer showed 80° in the shade; rather excessive at 5,000′. In the sun, of course it was well over 100° and I can recommend a tour of this nature in the same temperature to anyone wishing to get rid of superfluous fat. If "lard" does the lean earth any good the soil must have benefited considerably from the sweating passage of our company to-day.

The village has a simple palisade defence which does not even surround the village entirely. It is evidently strong enough to look after itself.

Just inside the entrance to the village is the local Golgotha. The relics are suspended by cane from stems of *Dendrocalamus sikkimensis* set in the ground at an angle. There was one old skull, a very large one, flanked by one of last year's vintage, a foot and

some other trifles. The man who provided last year's trophy had had his occiput neatly shaved off probably as he ran the gauntlet in an ambush.

Water had to be obtained from a nullah some distance away. The pools used by the village were most uninviting being full of muddy scum covered water used by mithun and pigs as well as by humans.

8th day.—To Choemi. A hot day but a reasonable march as marches go in these hills. *Melia toosendan*, with mealy violet flowers, was just bursting into bloom. *Ulmus lancifolia* was seen near Choemi and only once during the whole tour. All the valleys were filled with *Congea tomentosa*, a very conspicuous scandent shrub with its lilac involucral bracts.

The village was surrounded by clumps of the bamboo *Dendrocalamus sikkimensis*, which is used everywhere in the hills for carrying water. There were no defences that we could see.

We visited the "morungs" or young men's houses of which there were several. At each we saw a cock spread-eagled at the apex of the roof just as if it were flying out of the gable. Inside were a few rough planks for sleeping upon. Beside the door outside was a rack upon which were placed a row of old skulls. Cane ropes cut near the roof seemed to indicate that the fresh heads, which are suspended in front of the morung, had been removed for safety.

Just beside the morung was the xylophone or drum. To make this an enormous specimen of *Cedrela febrifuga* had been felled and hollowed out, leaving only about 2″ of wood all round. Inside was a large stone, which when rolled from side to side caused the hollow stem to give forth a loud booming sound.

I noticed one man wearing a decoration which I had not seen before but which Hutton tells me is common in this area. This consisted of half an enamelled soup plate hung on a string round the neck with the cut edge upwards. It never occurred to me to take a photograph of this and I have regretted it ever since.

9th day.—To Longmatrarre. This march was horror.

The day was extremely hot, the march a long one involving the crossing of five spurs, there was no shade and little water to be got.

Chief of Purotomi and his son (Semas).

Row of skulls in the morung. Choemi.

My bull-terrier and Hutton's spaniel were almost all in when we arrived at Sampurre, half-way, and halted for lunch. We were able to get water for the dogs at this place and it rapidly revived them.

There are salt springs in nearly all the valleys around here. The salt is obtained in the usual fashion by evaporating the spring water in earthen bowls over a fire.

In the fields through which we passed were many *panjis*, nasty looking slivers of *Bambusa tulda*, of all sizes. The Semas and Sangtams being at war there is continual raiding, and these *panjis* are put in to impede an attacking or pursuing enemy.

The ascent from the last stream up to Longmatrarre was very steep, and several of the coolies collapsed. Some of our coolies were Choemi men, a village which had had a head or two out of Longmatrarre not long before, and they were in dread of being cut up if they were seen in the village. Nothing happened, however, they were probably not recognised, and after receiving their pay and a handful of salt they set off at dusk on the return journey to their village.

10th day.—To Primi. The march brought us back into administered territory. It was a short one, but not without its ups and downs. The last ascent into Primi was very trying on account of the heat but we were enabled to get up by the aid of relays of *madhu* (rice beer) sent down from the village above. One particular brand was particularly refreshing and I partook largely of it. I regretted it for three days afterwards, being afflicted by a severe internal disturbance which was shared by a couple of interpreters who had also drunk the same *madhu*. The explosive effect was said to be due to the liquor having been brewed from mouldy millet.

And so back to Kohima, seven marches away, by easy stages.

ECOLOGY AND CULTURE OF KUTH
PART III.—KUTH ASSOCIATES

BY SHER SINGH, M.SC.

1. *General.*

The distribution and habitat of *kuth* have been indicated already in Part I. The object of this Part is to discuss the correct location of *kuth* in the Kashmir Alpine Zone, more especially to indicate the climatic and edaphic factors which are most suitable for the optimum growth of *kuth*. With this end in view, a few of the most important species which are invariably associated with *kuth*, and which are characteristic of certain types of soil, are mentioned in detail. The importance of the study of "indicators" is now well-known in the case of conifers, and it may be useful to extend this study as regards distribution and culture of *kuth*. By so doing, it is hoped, the ecology of *kuth* will be defined still further, and it will be possible for the layman to say off-hand by the observation of indicators as to whether a particular soil is or is not suitable for the growth of *kuth*. The value of ecology to the forester is indirect in that it supplies him with certain rules and observations which when applied to unsurveyed forest give indications of a pragmatic nature, which can be tested later, if necessary, by experimentation. The reason why these considerations are advanced is their actual usefulness in the field.

2. *Exact location of* kuth *in the Kashmir Alpine Zone.*

It has been already stated that *kuth* is pre-eminently a moisture-loving plant. Indeed, it may well be called the king of Kashmir-Himalayan mesophytes. This partiality for moisture, in turn, is a key for its exact distribution. As is well known, the peaks and the ridges of the hills are not always the most rainy parts, particularly in high mountains as the Himalayas are. The rainfall increases in the hills with altitude, but up to a certain height, decreasing above this limit. "The zone of the greatest rainfall," says Warming in *Plant Ecology*, "is the inferior limit of the cloudy belt." Hence the topmost portion of the Himalayan peaks is not so wet as the

lower limit of the cloudy belt which is considerably lower than the highest point of the hills. Apart from this peculiar distribution of rain, the hill-tops are always subject to movements of air which makes them drier than the lower sheltered parts. To this has also to be added the effect of insolation and direct exposure of the hill-tops to the sun, all of which factors co-operate to drive down *kuth* considerably below the peaks.

To the above have also to be added considerations regarding suitability of the soil conditions, for in the case of *kuth* edaphic factors are more important than even climatic factors, as the latter are practically constant above a certain minimal height in the Himalayas. The greater the depth and the wetness of the soil, the bigger the dimensions of *kuth*. Rocky portions which are special features of the elevated hill-tops are, therefore, particularly unsuitable for the growth of *kuth*. On the whole, the nature of soil is of prime importance to *kuth*, and so essential is it that even when all other conditions are suitable, the absence of this facility may rule out its occurrence.

The above considerations enable us to fit in the distribution of *kuth* in the following scheme of altitudinal zones which are arranged in the order of height downwards :

The Kashmir-Himalayan Alpine Zone.

(*i*) The *glacial zone* from 14,000′ upwards which is devoid of vegetation. The tail-end of this zone descends down as far as 12,000′ in the *nalas*, and is more extensive in winter than in summer.

(*ii*) The *sub-glacial zone* from 12,500′ to 14,000′. This zone includes the bare rocks and the rock-plants, the meadows and the mat-vegetation so characteristic of the Kashmir *margs*, also fissure-plants which are found in the crevices of rocks. This zone is colonised chiefly by grasses, annual or perennial herbs.

(*iii*) The *Juniper formation* from 12,000′ upwards encroaching into the former two zones. It comprises the upper limit

of the tree-growth, but here the growth is so stunted that the trees are generally dwarfed into bushes.

(*iv*) The *Dwarf-shrub heath formation* from 11,500′ upwards merging into the above zones, and colonized chiefly by the dwarf rhododendrons, namely *R. anthopogon* and *R. lepidotum*, and *Cassiope fastigata*.

(*v*) The *Birch formation* from 10,000′ upwards freely mixed with the above two zones in favourable localities. It generally grows mixed with the high-level fir which it over-tops. Occasionally, it is associated with *kharsu* (*Q. semecarpifolia*), but in such cases, the oak colonises the sunny southerly aspects, leaving the cool, sheltered slopes for the birch which grows up to the highest limit of tree-growth running into the sub-glacial zone. On lower levels, it has as its undergrowth *Rhododendron campanulatum* and the dwarf-willow (*Salix elegans*) which are its characteristic associates.

(*vi*) The *high-level fir zone* from 9,000′ upwards merging into birch or *kharsu*, as the case may be, and then shading off into junipers above. It is monopolised by the shaggy form of *Abies pindrow* which cannot be well distinguished from *A. webbiana*.

This alpine zone is then succeeded, on lower levels, by the ordinary fir, deodar or *kail* forests which belong properly to the temperate or sub-alpine zone. The zones indicated above are not very well defined as they merge into one another, but they give a fairly good idea of the average conditions. These zones may at first sight appear lower than corresponding zones in British India, but this is a special feature of the Kashmir-Himalayas due to rather heavy snowfall in winter.

The vertical distribution of *kuth* can now be fixed with certainty: it grows in the last two zones, namely, the birch and the high-level fir zones. The *margs*, the juniper and the heath formations are definitely ruled out because they are above the line of its optimum growth which may be drawn at 11,000′, which is also the lower level of the cloudy belt, and hence the zone *par excellence* for the mesophytes in Kashmir. At about this elevation, under the open shelter of birch

and the associated willow, the *kuth* reaches climax condition, and on either side it dwindles, due either to excessive exposure and insolation above, or excessive shelter and consequent suppression below. Nevertheless, the *kuth* has a wide altitudinal zone extending, as it does, from 8,000′ to 12,000′, but the zone of its optimum growth is from 10.000′ to 11,000′. As a result of this peculiarity regarding its distribution, a commonsense rule regarding its distribution can be stated thus: the *kuth* grows neither on the topmost elevations nor in congested fir forest, but some way below the top in half-sheltered, half-open birch forests which may or may not be mixed with fir. The birch is an ideal shade-tree for *kuth* as it is itself a mesophyte, a strong light-demander, and has an open, loose crown, conditions which are ideal for *kuth* which affects its under-canopy. The leaf-mould of the birch is a good fertilizer decaying, as it does easily, which is in strong contrast to the leathery leaf found in the heath bushland on higher elevations. To birch leaf-mould is also added that of the dwarf willows and other herbs found on this elevation. On the other hand, the litter of *kharsu* as also of the Himalayan heaths, being very hard and strong, produces a decidedly depressant action on the growth and extension of *kuth*, for which reason *kuth* in the *kharsu* zone loves open patches, leaving dense portions of the *kharsu* forest for more xerophytic or shade-bearing species. There is little doubt that the soil under the heaths and the *kharsu* is acidic which accounts for comparative scarcity of the *kuth* under the *kharsu*. On the whole, therefore, the birch-*kuth* formation, where it exists in the Kashmir-Himalayas, is a *climax formation* definitely indicative of the best mesophytic conditions, so characteristic of the Kishtwar and Kishanganga inner valleys.

3. *The effect of the grazing.*

Although *kuth* is not found in the *margs* on higher elevations, yet *margs* on lower elevation are not outside the *kuth* zone. The term *marg* is used in Kashmir for undulating plateaus which are excellent pasture lands. They are made in two different ways: either by the silting up of what were once hill tarns, or by glacial action which swept off all obstructions, leaving a flat plateau behind. Gulmarg

proper is probably due to glacial action, but Konsar Nag,—the Lake with the Outline of Lord Vishnu's Lotus Foot,—in Pir Panjal, Shopyan is definitely a hill-tarn which is silting up now by the avalanche—debris from the side slopes. These silted up *margs* have excellent deep soil, and are thus ideal for creation of artificial plantations of *kuth*. Moreover, the easy conformation of the Kashmir side of the Pir Panjal Himalayas, having "writing desk" slopes, makes them especially suitable for *kuth* gardens.

Indeed, it is neither the soil nor the climatic conditions which stand in the way of turning these *margs* into *kuth* gardens, but their excessive exposure to grazing which is very acute indeed in practically all flat hills or plateaus in Kashmir. *Kuth* is very sensitive to grazing, and its chief enemies in the upper hills are goats which come from the plains in thousands, if not in lacs, and which feed on *kuth* and its associates like swarms of hungry locusts. The *Gujars* who keep buffaloes and *Bakarwals* who keep goats are responsible for most appalling damage to *kuth* both by trampling and browsing, and it is they who are driving *kuth* farther and farther back to the uplands, where it dies of starvation, being then outside its true or optimum zone.

Indeed, the urgency of control over grazing especially by goats cannot be emphasised too strongly. It is necessary to emphasise the harmful effects of goat grazing on *kuth*, as it is believed by some forest officers that the goat helps *kuth* by its dung, but this is quite wrong. The good, if any, done by its dung is not only neutralised but wholly wiped out by grazing, which affects the very existence of the *kuth* fields in the Kashmir-Himalayas. One reason why *kuth* is often found in fissures and clefts of rocks, against all expectations, is that in such places, it is a refuge, a last remnant of what was once an ideal *kuth* field, but which has been exterminated by goat grazing and browsing—the crevices and cliffs being immune from such grazing on account of their precipitous slopes. At first sight, it might be thought that the existence of *kuth* in such crevices is not consistent with its mesophytic nature, but this is not the case. For, crevices in which *kuth* grows are not altogether rocky, but have within pockets of sufficiently deep

forest soil which has accumulated from the sides in many decades. Moreover, they are very often fed by subterranean channels of moisture which is very helpful indeed to *kuth*. This accounts for the occurrence of *kuth* in what would ordinarily be regarded an unlikely place for a moisture-loving plant such as *kuth*.

These dwindling patches of *kuth* on rocks and cliffs and crevices, even though they may be under birch, should not be confused with the climax *kuth* formation referred to in paragraph 2 above. We may call this as "*Recluse kuth*" and this retirement from active life is a direct result of oppression by the animal agency, *i.e.*, the goats and buffaloes, both of which are very harmful to *kuth* indeed.

In the forest, any number of stages may be seen which lie in between the climax formation, on the one hand, and the recluse formation, on the other, and the determining factor in such cases is the incidence and character of grazing. By manipulating this last factor, the recluse formation may once more be restored to the climax condition from which it degenerated.

4. *Indicators of over-grazed kuth areas.*

The following two species, which are abundantly found in the Kashmir-Himalayas, are very characteristic of over-grazed *kuth* areas :—

(*i*) *Cynoglossum microglochin*—*Lehandi* (Boraginaceæ).

(*ii*) *Senecio chrysanthemoides*—*Mogol* (Compositæ).

The former has bright blue flowers, and resembles the forget-me-not which belongs to the same family. Its flowers are, however, bigger and more attractive. It is easily identified by the bristly one-sided racemes and copious flowers ($\frac{1}{2}''$ in diameter). The other blue flower found copiously on the alpine slopes is *Salvia hians*, but the latter has 2-lipped flowers characteristic of the Labiate family, while the flowers of the *Lehandi* are round and 5-lobed. Nor should the plant be confused with the Jacob's Ladder (*Polemonium caeruleum*) which is frequently found on these elevations, for the latter has ladder-like leaves and faint-blue flowers, while the *Lehandi* has simple lanceolate leaves. The *Lehandi* is specially characteristic of comparatively dry

and over-trampled slopes. Some over-grazed *margs* in the Jammu Province are monopolised exclusively by this species, as Katkai, near Marg-Sahiban.

Mogol, which is aptly so called, as it has a round face, has bright yellow flowers arranged in compact panicles. This species grow in great abundance in all the *margs, gots* and *behaks* on high elevations, and so ubiquitous is it in Kashmir that it may well be called the "Gujar-consort." It grows equally on dry and wet slopes in association with different species of *Polygonum* (*Hablu*), and is a marked indicator of over-grazed areas, whether they lie in the *kuth* zone or outside.

Other species which are immune from grazing and usually occur with the above indicators are:

Euphorbia thompsoniana—Hirvi.
Morina longifolia—Chhalguddi.
Heracleum candicans—Phagmul.
Macrotomia benthami—Kahazban
Solidago virga-aurea—The Golden Rod.
The junipers—*Yithru.*
Wild mint.
Artemisia spp.
Pedicularis spp.

This formation which is so characteristic of the *margs* and other alpine pasture lands indicates that the incidence of grazing is so severe that *kuth* cannot flourish. Even if some stray patches of *kuth* plants are found here in inaccessible places, they are bound to be exterminated sooner or later.

5. *Indicators of suitable kuth soil.*

As already stated, the hill-willow (*Salix elegans*) and the birch are usual associates of *kuth*, and these together provide excellent shade and litter. But these species may occur in association with the aforementioned formation characteristic of over-grazed areas, in which case *kuth* would be conspicuous by its absence. Hence, it is necessary to find out certain other indicators which may be definitely characteristic of the mesophytic conditions suitable to the growth of *kuth*. The

following two species which are usually found in the *kuth* zone are very characteristic, provided they are not found as stray plants, but in abundance :—

(*i*) *Impatiens gigantea—Ban-til* (Geraniaceæ) ;

(*ii*) *Salvia glutinosa*—the yellow Salvia (Labiatæ).

The former is sometimes so characteristic of the higher *kuth* plantations that the whole plantation looks ruby red from a distance, *i.e.*, when the plant is in flower. Along with the *ban-til* are also usually associated other big species of the *Impatiens*. It sometimes grows in such great abundance that *kuth* plants are choked to death. Indeed, the giant *Impatiens* is rather an indicator of too much moisture than what is ordinarily needed by *kuth* and hence it may be said to *follow* rather than precede *kuth*. But the *kuth* and *ban-til* are so often intermixed that the *ban-til* may well be called an excellent indicator of soil suitable for the growth of *kuth*. However, so rapid and luxurious is the growth of the *Impatiens* that it very soon throttles *kuth* in early life, and instances have been seen in which *kuth* plants 5 years old were found no bigger than transplants just fresh from the nurseries, due to the fact that the associated *ban-til* formed a congested canopy effectively suppressing the *kuth*. Hence, *ban-til* should be regarded rather as a danger signal than a helpful species. Its usefulness, however, lies only in indicating that the soil has all the required moisture. Unless *kuth* is repeatedly weeded, this species is likely to swamp the *kuth* plantation, in much the same way as its sister species, namely, *Impatiens micrantheum*, monopolises the deodar ash-beds, choking out deodar regeneration.

The yellow salvia is properly speaking a plant of the deodar zone, affecting wet places, but in the Kashmir-Himalayas, it runs up into the *kuth* zone, being a common associate of the *ban-til*. It is, however, of secondary importance, and unless it is mixed with other *kuth* associates, it need not be taken seriously. These other associates are :

Dipsacus inermis—Uppalhak—Dipsaceæ flowers white.

Scabiosa speciosa—Dipsaceæ flowers blue.

Ainslea pteropoda (rarely *aptera*)—Compositæ. The Aaron's Rod.

Strobilanthes alatus and other spp.—Acanthaceæ.

Akar-kara—Umvilleferæ Fl. white umbel.

Male fern (*Kakashi*).

Artemisia parviflora.

Galium asperifolium—Rubiaceæ.

The Golden Rod.

Occasionally *Viburnum foetens* (*Guchh*).

This formation, wherever it occurs in a representative character, is indicative of suitable moisture conditions needed by the *kuth*. But no single species by itself is sufficient to indicate this. One characteristic of this formation is that many of these plants attain very big size, as big indeed as the associated *kuth*, sometimes man-high as in the case of the *ban-til* and the white and blue teasels. This is a natural consequence of the local moisture conditions. For the same reason, this formation occurs usually on either side of the hill *nalas*, below snowline, but considerably above the forest belt. The associates of *kuth* are thus pre-eminently mesophytes. Like birch they shed their leaves in winter, to re-grow them in spring. This gives these plants the needful rest which also explains their fitful activity in the growing season, a marked feature of the *kuth*.

6. *Late flowering of kuth.*

Ordinarily the sub-glacial and the alpine plants flower early in spring, very often before their foliage is fully developed. The cause for this is to be sought in brevity of the vegetative season and lowness of temperature. Some plants flower under the snow. The object presumably is that the short vegetative season may be fully utilized for maturing of seed. Spring begins in Kashmir in April and brings with it the violets, the strawberry, *Primula denticulata*, *Androsace retundifolia*, *Geranium* and *Anemone*. As the heat increases, other annuals also appear as *Podophyleum-emodi*, and *Primula rosea* in wet places in May. In June and July, when the summer is at its height, many species of *Corydalis* and *Pedicularis* flower along with the *Rhododendrons*. With the bursting of monsoon, many asters, salvias, and potentillas blossom. But the flowering of the *kuth* is deferred till August. This late flowering is a general feature

of the Compositæ family which can mature their small fruit in a comparatively short time. This late flowering of *kuth* is also connected with its strong woody root, so unlike the root of the alpine annuals. Thus the *kuth* root can make full use of the vegetative season sending forth blossom when maximum use is made of the growing season. Considering that the *kuth* can also propagate itself from the root, this deferring of the blossoming period can be interpreted as an effective adaptation to the alpine conditions which retard growth. For the same reason, it is observed that in *kuth* plantations on lower elevations, where heat is abundantly available, the flowering of *kuth* is more copious and earlier than on the higher slopes. For the same reason *Saussrea sacra* which grows on still higher elevations does not blossom until late in September. This is one reason why attempt is being made to grow *kuth* on lower elevations, *i.e.*, those varying from 8,500′ to 9,500′, as by so doing the plant flowers earlier, which is a great facility in dealing with the *kuth* plantations and in collecting the seed, than in the cold inhospitable places where *kuth* plantations occur.

These considerations give us further insight into the habits of the *kuth*, and enable us, therefore, to manipulate its culture with sufficient skill.

PINUS CARIBAEA

BY M. V. LAURIE, SILVICULTURIST, FOREST RESEARCH INSTITUTE, DEHRA DUN.

In his report on the 4th British Empire Forestry Conference in South Africa Mr. Trevor remarks as follows on this tree :—

> " This tree is a tropical pine of the Southern States of the United States of America and British Honduras. It has given excellent results in South Africa at various elevations and is stated by forest officers who have experience of it to stand more heat and more cold than *chir*. In British Honduras it grows practically at sea level. Its general appearance resembles *chir;* it is fire-resistant like *chir*, easily propagated, and sheds its side branches. The timber is excellent and could be classed with *chir*. This tree might solve the problem of the afforestation of the *chandars* of Pilibhit and South Kheri in the United Provinces and is well worth an extensive trial wherever frost inhibits the growth of sal."

He has now issued instructions that this pine is to be given an extensive trial at the Forest Research Institute, and as Silviculturists in the United Provinces and the Punjab may also desire to take this matter up, the following information regarding the tree and its propagation has been extracted from the records of the Silvicultural Branch.

Distribution and Habitat.—Pinus caribœa, more commonly known as " slash pine " occurs throughout Florida and in the southern portions (coastal plain) of the neighbouring states of Louisiana, Mississippi, Albania, Georgia and South Carolina, and in other parts of Central America.

Climate.—Characterised by " short mild winters " with some frost on about 120 days in the year on the average. Ice and snow are seldom seen. As regards cold therefore the conditions are considerably more severe than any that are likely to be encountered in India in the sub-Himalayan tract. The mean annual temperature is given as

67°F., which indicates a fairly high summer temperature. The rainfall is about 70 inches annually.

Soil.—*P. caribœa* is typically a tree of poorly drained flats and borders of swamps, but it will grow on better drained soils provided they are not too dry. It is found in a variety of situations but will never grow on dry sandy ridges. In this respect it is the opposite of *P. longifolia*, which likes a well-drained soil and does not tolerate swampy conditions. *P. caribœa* will tolerate a highly acid condition of the surface soil, and is the only species of pine that is found on the wire-grass and palmetto flats of the southern United States.

Natural regeneration.—Given fire-protection natural regeneration is easy to obtain, and it aggressively colonises abandoned cultivation without any other assistance. In dense grass areas, or where there is a thick layer of needles on the ground, better results are obtained if the ground is burnt over shortly before the seed falls.

Artificial regeneration.—(*a*) *Seed collection.*—*Pinus caribœa* produces large quantities of seed annually from the age of about 18 years. It has seed-years of maximum production every 3 to 7 years, but a considerable quantity of seed is usually available. There are 1,000 to 1,200 seeds per ounce (*i.e.*, about 4 times as many as in the case of *P. longifolia*). The fertility is 60 to 90 per cent., and the seed retains its vitality well in storage (70 per cent. after 2 years storage in tins, and 25 per cent. after 3 years storage in sacks, at ordinary temperatures inside a building). Seed can be obtained through the Forest Botanist, Forest Research Institute, Dehra Dun.

(*b*) *Direct sowing.*—Direct sowing followed by harrowing is a common method of raising crops of this species in South Louisiana, though generally transplanting nursery seedlings is preferred. Ploughed land broadcast and then harrowed gives practically 100 per cent. stocked plantations, but is more expensive. In such work about 1 to 3 lbs. of seed are used per acre. It is probable that in India line sowings with *taungya* between would be the most practical method. "Spot" sowing, spaced $7' \times 7'$, was tried in South America but did not give such good results. Experiments are being started

at Dehra Dun to determine the best method and the best time of sowing for north Indian conditions.

(c) *Entire transplanting.*—This is the method favoured in America and in South Africa for raising this species. It is remarked in the United States Farmers' Bulletin No. 1256 that "Experience indicates that slash pine possesses inherent vigour and favourable root form which make it one of the most adaptable species for transplanting," and instances are quoted where seedlings have been dug up and sent by parcel post and successfully planted at unfavourable seasons of the year. This is in great contrast to *Pinus longifolia* which is generally difficult to raise by transplanting (except in South Africa where they do so with apparent ease by raising the seedlings in kerosine tins cut longitudinally, which are later transported to the actual planting site and the seedlings planted out with a minimum of disturbance).

One-year-old seedlings are used in the case of slash pine and in America are raised generally in small nursery beds, 4 feet × 12 feet sown with half a pound of seed and yielding about 3,500 well developed seedlings (*i.e.*, 75 per square foot). The seedlings are 9 inches to a foot high with a small tap-root. In planting out it is essential that the roots do not become even partially dry. (This difficulty is got over by the half-kerosine-tin method mentioned above, as used in South Africa.)

Planting out.—This is done in the dormant season in America, *i.e.*, November to February. It will be necessary in North India to determine whether cold weather planting or planting at the beginning of the monsoon is best. The seedlings are merely notched in with a notching spade in America, two men and a boy being able to plant over 2,000 seedlings a day.

Early growth.—Growth in young plantations is, like *Pinus longifolia*, slow for the first four or five years.

Figures for the South United States are :—

1st year—8 to 12 inches.
5th year—6 to 10 feet.
30th year—50 to 70 feet and 6″ to 11″ diameter.

TABLE I.

Average growth in height and diameter of trees and number of trees per acre, growing in well-stocked, even-aged, slash pine stands on various qualities of land in Southern United States :—*

Age of stand	*Height*			*Diameter (breast height)*†			Approximate number of trees per acre
	Better land	Medium land	Poorer land	Better land	Medium land	Poorer land	
Years	Feet	Feet	Feet	Inches	Inches	Inches	
10	34	25	10	4·0	2·5	1·0	1,000 to 2,500
15	45	35	25	6·5	4·7	3·0	700 to 1,800
20	55	45	35	8·5	6·3	4·0	500 to 1,200
25	64	54	44	9·5	7·5	5·5	300 to 900
30	68	60	50	10·5	8·3	6·0	200 to 650
35	74	64	55	11·0	9·0	7·0	150 to 500
40	78	68	59	12·0	10·0	8·0	125 to 400
45	81	72	63	12·5	10·5	8·5	100 to 325
50	84	74	65	13·0	11·0	9·0	90 to 275

Resin production.—Pinus caribæa is a prolific producer of resin and gives the highest yield of crude turpentine of any American tree.

The following extract gives an idea of the quantities obtained in America :—

"In August of the first season (1919) this farmer reported that chipping once a week each thousand cups had yielded a dip of crude gum of about 7 barrels of 280 pounds capacity every 4 weeks. With an average of 6 dippings for the first season, the yield was 42 barrels per 1,000 cups. The trees are being worked for 3 to 5 years, or an average of 4 years. The flow of gum each season amounts to about a barrel less at each dipping. At this rate,

* Preliminary table based upon insufficient measurement and not to be considered as a final table.

† Diameters measured at breast height or 4½ feet above the ground.

1,000 cups yield 42, 36, 31 and 26 barrels of gum, respectively, for the four years, or a total of 135 barrels of gum. This does not include the "scrape" for which no figures are available. At $5 a barrel for crude gum, the current local price in August, 1919, the dip from 1,000 cups was worth $210, $180, $155, and $130, respectively, for the successive seasons for working, or an aggregate value of $675" (*i.e.*, a yield of over Rs. 2,000 per 1,000 cups in 4 years).

"After the trees have been turpentined for a period of 3 to 5 years they are sold for ties or lumber. In 1919 the timber in the standing trees brought from 15 to 25 cents each for ties, the equivalent of $3·50 to $4 a thousand feet for saw timber."

Resin tapping is commenced when the trees are about 10 inches in diameter (*i.e.*, about 30 years old), and trees of 10″ to 14″ are tapped with one face, and over 14″ with two faces per tree.

Timber production.—Although the chief value of slash pine is for turpentine production, it yields the hardest, heaviest and strongest wood of all pines in the United States. It is widely used for structural purposes, bridges, trestles, docks, buildings, beams, piles and joists. On account of its stiffness large amounts are used for railroad cars and on account of its hardness it is useful for wood paving and flooring. Young or sapwood trees of slash-pine are extensively used for railway sleepers on account of the density and hardness of the sapwood and its ability to take preservative treatment. It is also used for paper pulp, for good grades of brown wrapping paper, and is an excellent fuel.

In view of the above and the Inspector-General of Forests' statement that in South Africa *Pinus caribœa* stands more heat and more cold than *P. longifolia*; that it grows on the flat at sea level in latitude 30° S. with a summer rainfall—the same as at Dehra Dun in the northern hemisphere; that its propagation is easy, its resin yield and timber excellent, it is possible that this tree might be extremely useful in India in plantations in the United Provinces especially in the *chandars* of South Kheri and Pilibhit where so far no species has been found satisfactory on account of frost. *Chir*

pine has already demonstrated its use outside its real habitat. In Dehra Dun it has not suffered at all from frost and has done better than sal or any other local tree. In the Dehra Dun division it has grown quite happily in frost holes where no other tree would grow. There are very large areas of forest along the foot of the hills producing practically nothing and a considerable area in the plains of a tree as good as *chir* would be a great asset to any forest department.

References :

(1) " Slash Pine," by Wilber R. Mattoon—Farmers' Bulletin No. 1256, U. S. Department of Agriculture—1922.

(2) " Survival and early growth of planted southern pine in S. E. Louisiana," by R. W. Hayes and P. C. Wakeley. University Bulletin, Vol. XXI—N. S., No. 3, Part 2, Baton Rouge, Louisiana State—1929.

THE GOORAL

By Madan Pal, Forest Ranger, Chamba State

The *gooral*, like the *thar*, is a beardless wild goat, but it is much smaller in size than the latter. The height at the shoulders generally ranges from 26 inches to 28 inches. It is one of those ruminants which do not change their winter coats. The shaggy fur is of rufous brown colour at the back and palish-white at the thorax and abdomen, with a conspicuous white patch at the throat. It has no mane, but the hair is erect on the neck and round about the horns, forming a slight crest. The face is darker than the chin which has a bare muzzle. It has a beautiful black tail which does not measure longer than 3 to 4 inches. Both the sexes have black horns of equal length. The horns are short and curved slightly backwards. They have irregular ridges at the base which are divided partially by vertical grooves.

It is one of the most characteristic game animals of Chamba State and frequents elevations from 3,000 feet to 8,000 feet above sea level. Its favourite haunts are rocky ledges margining the grassy slopes, where it revels during clear mornings and evenings. At other times, it does not stick to its programme of bright sunny days, but is seen feeding at every hour of cloudy and stormy days.

The *gooral* is not very shy of men, but when scared, it produces a sneezing sound as a sign of alarm. Once started on its homeward

journey it does not rush headlong like a pig, but halts at intervals thus giving a chance to a sportsman to shoot it. It has a marvellous vitality, because many a time even when hard hit, it will go a considerable distance as if nothing were amiss.

The flesh of the *gooral* is harder than mutton and is relished by the local *shikaris* during winter. The hide is of many economic uses, but the hill people make it into a sack for carrying grain. Some quacks use the horns as a surgeon's glass cup for taking out blood. In addition to this some people use it as an appendage to their tobacco pouch for keeping tinder with which to ignite the fire for smoking.

The doe looks slightly inferior to the matured buck, which generally lives apart.

The pairing season is winter and the kid which is one at birth appears in the following May or June.

POISONOUS SPECIES OF RHUS

By J. Singh, Deputy Conservator of Forests, Upper Bashahr Forest Division

Both *Rhus wallichii* and *Rhus succedanea* which are well known for the corrosive properties of their sap are fairly common in Pandrabis range of Upper Bashahr Division (Punjab), and during my recent tour in this range two instances of their poisonous effect came to my notice.

In one case, when along with the territorial Range Officer and the beat-guard I was passing through a somewhat dense undergrowth in a forest in Salarang valley, a leaf of *Rhus succedanea* happened to fall upon the forest guard's hand. Within half an hour the hand began to swell and became very painful. On return to the camp, iodine was applied but it had no effect. During the night his hand blistered and altogether it was three days before the hand became normal.

A few days later, in another valley where the sawyers were working, I met two sawyers who during a heavy shower of rain took shelter under some poisonous species of *Rhus*, which they did not know. Here the rain-water dripping from the leaves alone was

sufficient to bring about the most virulent symptoms. So bad was the effect that the men were completely incapacitated for 10 days. The skin blistered very badly and after a couple of days started to discharge. The eyes became so swollen that they could not see at all. Irritation was extremely intense all over the body. Their necks also became swollen, and although some of the symptoms provoked more amusement than sympathy, the men were obviously in very great agony. Iodine, potassium permanganate, boracic powder and ointment were all tried, but did not give the least relief.

I would be very much interested to know if any Forest Officers have come across similar instances of *Rhus* poisoning and happen to know of any effective but simple cure for this poisoning.

THE USE AND MISUSE OF LAND

BY R. MACLAGAN GORRIE, D.Sc., F.R.S.E., I.F.S.,
LEVERHULME RESEARCH FELLOW, OXFORD
FORESTRY MEMOIRS, NO. 19, 1935.
Published by the Clarendon Press, Oxford, 1935.

The book is in the usual excellent style to which we are accustomed from the Clarendon Press, well illustrated with good photographs. It adopts the very excellent practice of giving a summary at the beginning. It is divided into eight chapters headed, Forestry as a factor in land management, Grazing and range management, Overgrazing as a primary cause of soil erosion, Value of vegetational

(*sic*) cover in streamflow control, Forestry as a factor in farm and village economy, farm erosion and its control, other examples of the misuse of land, and public and private control of land. The chapter headings themselves show the scope of the work and it is difficult if not impossible to give more of a summary, of the actual contents. The book is well written and as a statement of how serious the problem is and the general lines on which it should be tackled, leaves nothing to be desired. The author makes several points which, although known, are not perhaps generally realised as, for example, when he says that the main point to learn is that grazing must be planned and not left haphazard and again when he says that any plant no matter how virile, will succumb sooner or later to prolonged continuous heavy grazing, browsing or lopping, and yet again when he says that the normal geologic process of erosion is on the whole beneficial and even with the partial plant cover of arid regions, the natural balance between precipitation and cover is sufficiently stable to reduce erosion to a negligible rate. It is most important that anyone dealing with this problem should realise that although erosion cannot be stopped, it can be slowed down very materially. A further extremely important point especially for some of us in India is a table which he gives to show that forest cover is of relatively minor importance compared with the main issue which is the efficiency of *plant* cover as a whole, and his table shows that grass is five times better for stopping run off and sixty-five times better in preventing soil loss than bare ground. All these things are important to know and they cannot be hammered home too often. If I had to prepare for an examination on grazing and erosion this book together with its excellent bibliography would be a great help.

May I, however, voice a personal plea. I was personally disappointed when I had finished the book. I am more or less continuously faced with this problem of grazing and erosion as a live every-day matter in a very terrible form. With me it is a problem extending over hundreds of square miles. I see scanty grass and the cattle starving, literally I see the good soil washed away, fields going out of cultivation and the people starving, I see villages in the process of

disappearing and the people homeless, and when I read this book hoping for some answer to my problem, I found really none that helped me. I am told to plan the grazing, I am told to reduce it so as to make it consistent with what the land can support, I am told in fact many extremely valuable things, most of which I knew, but none of them really get to grips with the actual practical problem. I want to know how ? If I could persuade the villagers to protect even half their area every alternate year, will that be sufficient to solve the erosion problem ? Will it produce a sufficiently better crop of grass to make the villagers realise that it is actually to their advantage ? How long will it take to show definite results ? If this is not sufficient, is it better than nothing ? If I can do it on a three-year rotation instead of a two-year rotation, will that be sufficient ? What is the ideal grazing rotation, assuming grazing has to be provided for ? These and dozens of other practical questions have to be answered before I can begin. May I again apologise for what is probably an unfair criticism of the author's book ? This is such a burning question with us in parts of my Province that perhaps naturally I am disappointed when I pick up a book and find the chapter headings such that they apparently deal directly with the problem with which I am faced, and then in actual fact help me very little on the practical method of doing anything. I cried for bread and the author gave me a stone and it is not much satisfaction to me if he answers that he never intended to give me anything else. I want a book badly which will help me to tackle the particular problem as it exists in India. The author obviously has a greater knowledge of the general problem than I have. Won't he please sit down and write that other book ?

S. H.

Note.—It is suggested that the writer of the above should try:—

(1) Closure for 3 years with grass cutting only for the rejuvenation of the pastures;

(2) Thereafter, moderate grazing or, what is better, rotational grazing of part of the area, so that the grass is not subject to grazing

for 12 months in the year, alternately grass cutting plus grazing should give good results. Closure to grazing combined with afforestation had a wonderful effect on the grazing value of the Fisher forest at Etawah where fees up to Rs. 2 per mensem were willingly paid for grazing.

Closure to grazing in Hoshiarpur has been profitable to the villagers who cut the grass and use it themselves or sell it. Grazing should only take place when there is something to graze, for more than half the year in India there is nothing to graze and the grazing animals do nothing but harm.

Overgrazing and the overstocking of farms is admitted to be the greatest cause of erosion in South Africa, the only remedy for which is light grazing.—C. G. T.

EXTRACTS

EFFECT OF ANNUAL GRASS FIRES ON ORGANIC MATTER AND OTHER CONSTITUENTS OF VIRGIN LONGLEAF PINE SOILS.[1]

By S. W. Greene.[2]

Associate animal husbandman, in charge McNeill (Miss.) Experiment Station, Animal Husbandry Division, Bureau of Animal Industry, United States Department of Agriculture.

INTRODUCTION

The winter burning of dead grass left unconsumed by grazing animals from the growth of the previous season is a world-wide practice of very ancient origin, particularly in humid regions where uncut grass does not cure into palatable winter forage. By the use of grass fires the Indians maintained open grazing lands for the bison and pronghorn antelope, the largest herds of grazing animals that the world has known. This practice of the Indians was considered beneficial to the land and was continued by white men, particularly in the humid longleaf pine region of the South, as a means of keeping down the underbrush and improving the pasturage for cattle. In the longleaf pine region a large part of the virgin soil is burned over each year. Hilgard (10, p. 495), [3] writing of the longleaf area of southern Mississippi, stated:

"The land * * * affords but indifferent pasturage, except the first season after burning-over; probably because of the effect of the minute amount of ashes so added."

---

[1] Received for publication Feb. 18, 1935; issued July, 1935. The data reported were obtained in a co-operative grazing and reforestation experiment conducted at the McNeill Experiment Station, McNeill, Miss., by the Bureaus of Animal Industry and Plant Industry and the Forest Service of the U. S. Department of Agriculture, and the Mississippi Agricultural Experiment Station.

[2] The writer is indebted to H. R. Reed, formerly of the Bureau of Plant Industry, who spent considerable time in making the final legume counts. Acknowledgment is made also to W. F. Hand, State chemist of Mississippi, for analyses of soils and for determinations of the protein and ash content of grasses.

[3] Reference is made by number to Literature Cited.

Referring to the effect of grass fires on forest growth, Harper (8, p. 668) in 1913 stated:

" * * * they return immediately to the soil the mineral plant food stored up in the leaves. The amount of the available plant food in the soil of the pine forests is usually rather limited, and these frequent fires thus enable the pine to do business on a small amount of capital, as it were."

The literature does not seem to record any conflict with the empirical observations of the users of grass fires until recent years, when objections to the use of fires were made on the theoretical basis that the fires destroy organic matter and nitrogen to the detriment of soil fertility. The general unsupported argument against the use of fire was stated by Van Hise (24, p. 238) in 1910, as follows:

" The fires do not simply confine themselves to the timber, but they burn the humus in the soil itself. Frequently, after a great forest fire, and especially if the fires run over the same area two or three times, there is left of the soil, sand, and other minerals, but little of the original organic material."

Mattoon (16, p. 48) in 1931, states:

" The leaves, or " straw " from pines contain considerable nitrogen and small amounts of phosphoric acid and potash. A ton might contain these essential fertilizing elements to the value of $2 to $4. An unburned pine wood may have as much as 10 to 15 tons [per acre] of leaves and other organic matter."

However, Mattoon gives no basis for his statements and does not indicate any way in which organic matter and nitrogen, on top of the virgin soil, might be recovered in the soil for the use of growing plants.

RELATED INVESTIGATIONS

Alway and Rost (2), from experimental work in 1918-19, found that burning did not influence the immediate fertility of the mineral soil and concluded that any loss in productivity would depend on the loss of nitrogen contained in the forest litter, since the mineral elements are returned immediately to the soil by fire. In later experiments Alway found that burning the forest floor as compared with plowing under the natural litter had no significant effect on crop production either immediately following (1) or over a series of years. [1]

Greene (7), in 1929, showed that cattle made 44·4 per cent. greater gains on burned native grass pastures than on similar unburned pastures over a period of 4 years.

The literature in regard to the accumulation of humus and nitrogen in cultivated soils and their effect on crop production is voluminous. Such literature, however, is concerned exclusively with the problem of green manuring, or the turning under of plant residues, and does not consider the problem of humus and nitrogen or their accumulation in soils that have not been plowed and are to be handled as virgin soils in forests or pastures where vegetation is either burned or left to decay where it accumulates on top of the soil.

[1] Unpublished information.

The emphasis placed by popular agricultural literature on the value of organic matter plowed under, without regard to the quality or quantity of the material to be turned under, has, no doubt, created a tendency to overestimate the fertilizing value of vegetative growth on virgin soils. Moreover, the theoretical grounds on which deductions may be based are not always realized in practice. Such a concept for virgin soils leaves out of consideration the methods by which nature incorporates plant residues with the soil.

The importance of organic matter in the soil has always been recognized, but a sharp distinction must be drawn between organic matter in the soil and on top of the soil. According to Pieters (19), organic matter on top of virgin soils may be incorporated with the soil by the action of water or glaciers, by rodents, insects, earthworms, and micro-organisms, and by the sharp hoofs of grazing animals, but chiefly by the decay of plant roots.

Soil nitrogen in any form is derived originally from the gaseous nitrogen in the air and is a rather unstable and transient material, the gains and losses of which are perhaps not yet fully explained. Small quantities of gaseous nitrogen, in forms available to plants, are added to the soil by rainfall and by free-living micro-organisms, but the chief source of increase is through the action of the micro-organisms associated with legumes. Finnell and Houghton (6) found that 15·45 inches of rainfall in 1930 added 1·42 pounds of nitrogen per acre. No measure of the quantity of nitrogen per acre fixed by free-living organisms seems to have been obtained, and the effect of this class of organisms appears to be almost purely speculative.

Nitrogen is an essential element of plant growth, and the nitrogen content of the soil is closely associated with the organic-matter content. Plants other than legumes, grown and left in place, do not add nitrogen to the soil but transform soil nitrogen into organic nitrogen with a loss to the soil in the process. Because of the known ability of legumes to store a considerable quantity of nitrogen extracted from the air, in both the root and above-ground portions of the plant, the maintenance or increase of nitrogen in virgin soils may depend largely on the character of the plant population.

In annual legumes one-fourth to one-third of the total nitrogen has been found by the Mississippi Agricultural Experiment Station to be in the portion of the plants below ground,[1] and in some perennial legumes nearly half of the nitrogen is in the underground portions (19, *p*. 74).

Lyon and Bizzell (15), by lysimeter experiments for a period of 15 years, in which the nitrogen added by rainfall and manure and removed by the crops and in the drainage water was carefully measured, found that in tanks containing growing legumes there was an increase of nitrogen in the soil equivalent to about 60 pounds per acre per year. When the tanks did not produce crops for 10 years and then grew nonlegumes for 5 years, the loss of nitrogen from the soil was at the rate of about 25 pounds per acre per year.

Sievers and Holtz (21) have shown that both the organic-matter and nitrogen increase in soils is influenced by the nitrogen-carbon ratio of the plants grown on the soil or turned under.

[1] Unpublished information.

In the mature stages of plants it has been shown by LeClerc and Breazeale (12) and others that leaching of the mineral elements from plants in place occurs in considerable quantities, but that leaching of nitrogen is relatively unimportant.

Soil nitrogen is decreased by the removal of crops which contain nitrogen, by conversion into ammonia gas and gaseous nitrogen through the action of micro-organisms, both bacteria and fungi, and by leaching.

Heck, Musbach, and Whitson, as reported by Clark (4), found that the loss of organic nitrogen from manures on the ground in free circulation of air is much more rapid than below ground. The same relation between nitrogen in the above-ground and below-ground portions of mature plants would be indicated.

Nitrate nitrogen, the form most available as a plant nutrient is readily soluble and is quickly leached away if not taken up by growing plants. Lyon and Bizzell (14) have shown that the loss of nitrogen by leaching was 17 times as much on uncropped land as on cropped land. Because of the loss of nitrogen both as ammonia and as nitrate on uncropped land, the use of winter cover crops as well as summer growing crops is generally advocated to conserve nitrogen on tilled soils in humid areas with mild winters. On virgin soils a constant maximum growth of herbage is indicated to conserve soil nitrogen.

The foregoing references underlie the concept derived from the experimental data to be presented. Although fire has, no doubt, been the most violent if not the most active chemical reaction present on the soil of the virgin longleaf pine region and is known to have a very active influence on the plant population of virgin soils, no data other than the limited work cited have been found showing the influence of frequent or annual burning on the fertility of the soil, as compared with protection from fire.

EXPERIMENTAL PROCEDURE

A tract of 320 acres of virgin land near McNeill, Miss., reproducing to longleaf pine about 20 years after the virgin timber had been removed, was fenced and divided into four experimental areas in 1923. Previously the land had been unfenced open range, subject to annual or periodic burning and lightly grazed by cattle. Since the fenced area was a part of a large area of open land with no natural barriers to fire or grazing, it is believed that the areas as divided had received uniform treatment before being fenced. This area is typical of the rolling longleaf pine hills of southern Mississippi. It has an elevation of 230 feet, and is well drained, as are the soils of the heavier type in longleaf pine areas.

Two areas of 150 acres each were grazed, one of which was burned annually during winter or early spring, beginning in 1923. Two 10-acre areas were not grazed, and one of these was burned annually. A detailed soil map of the area, made by the Bureau of Chemistry and Soils of the United States Department of Agriculture, was used as an aid in establishing the experimental areas and plots.

No soil analyses were made at the beginning of the experiment, since the studies undertaken concerned mostly problems of forage production. Soil analyses were made later in seeking an explanation of differences in forage growth under different treatments. Detailed studies of the variations in the plant population were made annually.

To determine the effect, on the soil, of burning the grass annually over a considerable period of time, analyses were made of soil samples collected on April 23, 1929, about 3 months after growth had begun in the spring and during the season of flush growth, and on January 10, 1930, during the dormant period. As it was recognized that individual samples might vary in chemical composition within a radius of a few feet, five random samples were taken to a depth of 6 inches for each soil type, and these five were mixed thoroughly to form a composite sample.[1] In addition to the principal studies relating to organic matter and nitrogen content of the soil, other tests deal with density of plant growth, moisture content, and micro-organisms in soil from burned and unburned areas.

EXPERIMENTAL RESULTS

ORGANIC MATTER AND NITROGEN

Table 1 shows the content of organic matter and nitrogen from moisture-free samples of soil on the dates mentioned.

TABLE 1.—*Organic matter*[2] *and nitrogen in composite samples of moisture-free soils taken Apr.* 23, 1929, *and Jan.* 10, 1930, *from soils subjected for* 7 *and* 8 *years, respectively, to the treatment indicated.*

APRIL 23, 1929, SAMPLES.

Soil type[3] (fine sandy loam).	GRAZED AREA				UNGRAZED AREA			
	Burned.		*Unburned.*		*Burned.*		*Unburned.*	
	Organic matter.	Nitrogen	Organic matter.	Nitrogen	Organic matter.	Nitrogen	Organic matter.	Nitrogen.
	Per cent.	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*	*Per cent.*
Orangeburg	2·41	0·C33	2·30	0·050	2·47	0·045	2·33	0·040
Norfolk	3·36	·046	2 62	·050	2·67	·050	([4])	([4])
Ruston	4·81	·053	2·40	·050	([4])	([4])	2·98	·050
Kalmia	3·29	·053	2·89	·090	([4])	([4])	([4])	([4])
Average	3·47	·046	2·55	·060	2·57	·047	2·65	·045

JANUARY 10, 1930, SAMPLES.

Soil type	Grazed Burned Organic matter	Grazed Burned Nitrogen	Grazed Unburned Organic matter	Grazed Unburned Nitrogen	Ungrazed Burned Organic matter	Ungrazed Burned Nitrogen	Ungrazed Unburned Organic matter	Ungrazed Unburned Nitrogen
Orangeburg	3·62	0·06	2 26	0·04	4·21	0·07	2·85	0·05
Norfolk	3·87	·06	2·87	·05	3·88	·07	([4])	([4])
Ruston	3·47	·07	2·41	·04	([4])	([4])	2·24	·04
Kalmia	6·90	·10	3·15	·07	([4])	([4])	([4])	([4])
Average	4·45	·07	2·67	·05	4·05	·07	2·54	·04

[1] Soil samples were collected by the Southern Forest Experiment Station of the U.S. Forest Service. Soil analyses were made by W. F. Hand, State chemist of Mississippi.

[2] Analysis made by ignition method.

[3] For description see soil survey by Smith and Carter *(22)*.

[4] No sample taken.

In samples taken in April the average organic-matter content of soil from the burned areas was 3·17 per cent. as compared with 2·59 per cent. for the unburned areas, or a ratio of about 1·2 : 1. The corresponding figures for nitrogen content were 0·047 and 0·055, or a ratio of about 0·9 : 1. Although the samples collected in April showed a variation in organic matter in favor of the burned areas in each instance, the proportion of nitrogen to organic matter was sometimes in favor of the burned areas and sometimes in favor of the unburned areas. It is known that the available nitrate nitrogen is taken up rapidly in the early flush of forage growth. A simple calculation from the known yields and analyses of the forage shows that the difference in nitrogen content for different areas, after the growing season had advanced approximately 90 days, may have been sufficient to be reflected in the analyses of the soil.

The soil samples taken January 10, 1930, during the dormant period of plant growth for the region, were repetitions of samples taken April 23, 1929, during the season of flush growth of the native vegetation of the region and after about 3 months of the growing season.

In the soil samples taken in January, the variation in organic matter and nitrogen from burned and unburned areas during the dormant period for plant growth, as shown in table 1, was reasonably constant. The average content of organic matter in all samples from burned areas was 4·32 per cent. as compared with 2·63 per cent. for the unburned areas, or a ratio of about 1·6 : 1. The corresponding average differences in nitrogen content were 0·072 per cent. and 0·048 per cent., or a ratio of 1·5 : 1. The percentages of organic matter and nitrogen were in all cases higher on the burned areas. The highest percentage of organic matter from any unburned sample did not equal the lowest from any burned sample.

The differences in January between the burned and unburned areas in both organic matter and nitrogen were of such magnitude as to be significant. A difference in weight of 0·01 per cent. in a moisture-free sample of soil to a depth of 6 inches would amount to approximately 155 pounds per acre, according to the weights of Mississippi soils as given by Logan (13). In terms of nitrogen for soils that are deficient in this element, a difference of 0·001 per cent. when analysis is made to the third decimal point, is significant. The average difference in percentage of nitrogen was 0·024 per cent. (0·072—0·048), which represents approximately 400 pounds of nitrogen per acre, in favour of burning. This difference is equal in amount to the nitrogen in an application of approximately 2,400 pounds of nitrate of soda, the common nitrogenous fertilizer of the region.

The conclusion seems warranted that sampling soils for nitrogen during the growing season would give unreliable comparisons for soils that are producing crops varying widely in quantity and quality, especially for soils deficient or low in nitrogen, where the current supply of available nitrogen is a limiting factor for plant growth.

With respect to the soil samples taken at a time of year when plant growth is practically dormant, and over a large area which previously had been subject to uniform treatment, it is reasonable to conclude that the differences in soil analyses were due directly or indirectly to differences in the treatment while under control,

GROWTH OF FORAGE

Throughout the course of the experiment, the growth of forage in the different areas was observed annually on a series of more than 50 rectangular plots of 0·01 acre each.

In 1930, after 8 years of annual burning as compared with complete fire protection over the same period, weights were taken of forage on burned and unburned areas where neither had been grazed (table 2). Two of the 0·01-acre plots were used for each of the two predominating grasses, *Andropogon scoparius* (little bluestem) and *A. tener*, where they were growing in practically pure stands, and two plots for mixed stands. These were selected in the open, away from shade and only a few yards apart on each side of the fire-line so that all conditions would be the same except the factor of fire.

TABLE 2.—*Yield per acre*[1] *of the predominating grasses on ungrazed areas, burned and unburned, for 8 years.*

Kind of grass.	Green plant per acre on—	
	Burned area.	Unburned area.
	Pounds.	*Pounds.*
Andropogon scoparius	5,121	3,623
A tener	6,957	1,206
Mixed stand	5,749	2,415
Average	5,942	2,415

[1] The grasses were clipped about one-half inch above the ground.

The differences in weight on the burned and unburned areas were due chiefly to the reduction of stands (smaller number of plants per acre) on the unburned plot, although there was a reduction in the vigor of growth on this plot as shown by the characteristic spindly growth of plants that are required to grow through a mulch that reduces light in the early stages of growth. The average of the maximum heights of the plants on the plots studied in the burned area was 20 inches. The corresponding figure for the unburned area was 30 inches. From these studies it appeared that the density of the grass growth on areas that were not burned was reduced from year to year by the smothering or mulching effect of the dead debris of the grasses themselves. On unburned areas where the grasses were further blanketed by the "strawfall" from pine saplings, forage growth was almost completely eliminated in the course of a few years. This reduction in forage growth through the action of dead debris on unburned land is cumulative from year to year and is most rapid where the forage is not grazed by cattle.

Laird (11), working with five important sod-forming grasses under pasture conditions, found that approximately 50 per cent. of the dry weight of the plants

was in the root system and that most of the weight of the root was in the 8 inches just below the surface of the soil.

On the experimental area 30 species of native legumes,[1] most of which are perennials, occur in considerable abundance. In 1931, after 9 years of burning, counts of the legume plants were made in each of the 0·01-acre plots in the four experimental areas. From these counts the number of legume plants per acre was calculated, as shown in table 3.

TABLE 3.—*Comparison of legume plants on burned and unburned areas.*

Treatment of area.	LEGUME PLANTS PER ACRE ON—	
	Grazed area.	Ungrazed area.
	Number.	*Number.*
Burned annually (9 years)	35,700	41,500
Unburned	27,600	17,600
Difference	8,100	23,900

From tables 2 and 3 it appears that the cumulative smothering effect of unburned plant debris not only reduced the grasses on the protected areas but also reduced the legumes to the extent that after 9 years of fire protection they were less than half as numerous as on the area burned annually over the same period, where neither area had been grazed. These counts confirm observations made in Georgia by Stoddard (23) and in Florida by Harper (9). In the grazed areas the number of legumes on the protected plots also was materially less, though the difference was not so marked.[2]

A strip survey of the forage cover of the entire country in which the experimental area was located showed that the legumes were most abundant on the well-drained soils. This observation confirms those of previous investigators.

The burned and ungrazed area had one more legume plant for approximately each 2 square feet than had the unburned and ungrazed area. The probable effect of this difference in legume population on the quantity of nitrogen gathered from the air is obvious. It is also clear that doubling the plant growth per acre would greatly increase the accumulation of organic matter in the soil through decay of plant roots.

CRUDE PROTEIN AND ASH IN FORAGE

It is to be expected that the difference in nitrogen in soils from burned and unburned areas, as shown in table 1, would be reflected somewhat in a difference in crude protein in forage from those areas. The quantity of the protein in plants

[1] The seeds of 20 species found at McNeill, Miss., have been determined by Stoddard (23) to be important quail feed.

[2] A sampling process based on studies of representative small plots at regular intervals.

indicates the fertility of the soil, particularly soil that is deficient in nitrogen. To compare the forage from the burned and unburned areas for content of crude protein, and also for ash, samples of the two predominating species of grasses, *Antropogon scoparius* and *A. tener*, were taken in 1929 and again in 1931 after 7 and 9 years of burning and fire control, respectively. Composite samples were made by cutting and mixing the current growth from a large number of random locations. Samples were taken from April to June during the flush of the early season's growth. Table 4 presents a summary of the results obtained. No sample from the unburned areas equaled the comparable sample from the burned areas.

TABLE 4.—*Comparison of the average crude protein and ash content of moisture-free samples of grasses on burned and unburned areas.*

Treatment of area.	Crude protein.	Ash.
	Per cent.	*Per cent.*
Burned annually (7 and 9 years)	10·15	7·92
Unburned	7·77	6·86
Difference	2·38	1·06

A difference of 2·38 per cent. in crude protein is sufficient to affect the feeding value of the forage, and the sale value of commercial feeds is determined largely by the difference in protein content. A difference of 1·06 per cent. in ash also would affect the value of forage plants as feed (3,20).

MINERAL FERTILIZING ELEMENTS

In 1930, after 8 years of burning and fire control, soil samples representing the four soil types in the burned and unburned areas were analyzed for their content of mineral elements, namely, aluminum oxide, magnesium oxide, calcium oxide, potash, phosphoric acid, and sulphur trioxide. The total quantity of these minerals in the ash was as follows: Burned areas, average of all samples, 2·581 per cent; unburned areas, 1·899 per cent; difference in favor of burned areas, 0·682 per cent. No sample from the unburned areas equaled the comparable sample from the burned areas.

These analyses of the mineral fertilizing elements of the soil substantiate the statements of previous investigators, already presented, that burning does not deplete the mineral fertility of the soil, but returns it directly to the soil where it becomes quickly available for the growth of plants.

SOIL MOISTURE

As a secondary influence of increased organic matter in the soil, it would be expected that soil moisture would increase because of the known water-holding capacity of organic matter in soil.

The region under consideration has a heavy rainfall distributed throughout every month of the year, November having the minimum amount. The average rainfall in November over a 27-year period was 3 inches. Ordinarily there is no deficiency in surface moisture except on steep slopes or light sandy soils, although during periods of drought the soil moisture is rapidly reduced.

The data obtained on soil moisture were based on samples representing different soil types and varying degrees of vegetative growth. Individual samples collected during the growing season accordingly showed considerable variation with no particular trend. In view of the rather wide variation in organic matter for different soil types and the patchy vegetative growth on the unburned pasture, due to spotted grazing, it was realized that the different conditions might give rise to unreliable comparisons unless large numbers of samples were taken. Accordingly more than a thousand individual samples were obtained to make more than 200 composite samples. These represented soil from the surface to a depth of 12 inches for both the burned and unburned areas.

Each of the composite samples was made up of from 5 to 10 individual samples taken within a radius of about 10 feet. No sample was taken less than 24 hours after a rainfall. The results of this investigation are given in table 5.

TABLE 5.—*Average percentage of soil moisture in samples of soil from burned and unburned areas, Apr. 21—Oct. 9, 1931.*

Treatment of area.	Composite samples.	Moisture.
	Number.	*Per cent.*
Unburned	124	9·63
Burned	119	9·46
Difference	5	·17

Table 5 shows no significant difference in the moisture content of the burned and unburned areas. However, in considering the moisture data, the wide variation between plant growth on the burned and unburned areas must be taken into account since a ton crop of hay per acre requires the use of about 250 tons of water during the period of its growth (18). When the moisture taken from the soil and transpired by a much larger forage production is considered, the conclusion seems warranted that the additional organic matter in the soils on the burned areas must have increased their water-holding capacity to a considerable extent. This is further confirmed by moisture determinations of surface-soil samples taken in May 1930 during the flush of plant growth, and in December after the plant growth was mature. The popular conception is that a mulch of litter on top of the soil conserves moisture at the surface, and the samples which furnished the data shown in table 6 were taken to a depth of 1 inch.

TABLE 6.—*Soil moisture of burned and unburned areas at a depth of 1 inch.*

Condition of area	Moisture content of soil [1] on—		Condition of area.	Moisture content of soil [1] on—	
	May 21, 1930.	Dec. 6, 1930.		May 21, 1930.	Dec. 6, 1930.
	Per cent.	*Per cent.*		*Per cent.*	*Per cent.*
Burned :			Unburned :		
Grazed ..	10·3	11·1	Grazed ..	9·9	9·9
Ungrazed ..	9·3	14·9	Ungrazed ..	10·9	13·2

[1] Rainfall for the 30 days ended May 19 was 3·25 inches and for the 30 days ended Dec. 5, 6·37 inches. Of these quantities 2·09 inches fell on May 19 and 0·55 inch on Dec. 5.

Although the burned and ungrazed area produced a forage growth more than double that on the adjacent unburned and ungrazed area, it still maintained its moisture content and ended the growing season with 1·7 per cent. more moisture.

Merkle and Irvin (17) have shown that laboratory results in the conservation of moisture by a mulch, where the soil tubes are in contact with a water table, do not apply in practice to field conditions where no such water table exists near the surface of the soil. In the latter case, the conclusion seems warranted that the maintenance of soil moisture on the burned areas was due to the increased organic matter in the soil, and that the mulch of accumulated debris on the unburned area did not have the effect popularly described.

Water absorbed by plant debris, in place on top of the soil, is subject to the same sharp division from soil moisture that has already been made between organic matter on top of soil and that incorporated with the soil. It is obvious that any water absorbed by the litter is held away from the soil until it is evaporated. It is obvious also that evaporation is more rapid in the presence of free-air circulation than after moisture is absorbed in the soil. However, the water absorbed directly by the surface litter is a very small percentage of the total rainfall. Samples of a 9-year accumulation of three kinds of plant debris were carefully removed from measured areas on the experimental tract and air-dried. The quantity of water they would absorb to the saturation point was then determined by weight and calculated in terms of inches of rainfall. It was found that the maximum quantity, 0·11 inch, was absorbed by pine straw. Oak leaves absorbed 0·09 inch and dead grass 0·05 inch.

A mulch of plant debris in humid areas appears to affect the soil moisture chiefly by suppressing plant growth, which would take up moisture and transpire it through the leaves. The quantity of water absorbed by such litter is so small that it would not influence soil moisture to any appreciable extent, although it might absorb light showers and deprive surface-feeding plants of a temporary supply of moisture that would freshen plant growth in times of dry weather. Such effects on

pastures from showers are well known. It has already been shown that accumulated litter did not raise the soil-moisture content even where it has suppressed plant growth about one-half. Any effect popularly ascribed to a leaf litter, in this case did not compensate for the increased soil moisture held in an adjacent soil with a higher organic-matter content, although the adjacent burned-over soil was supporting about twice the plant growth per acre.

SOIL FLORA

The micro-organisms of the soil are known to be greatly increased by the addition of organic matter, since the organic matter furnishes the energy and nitrogen necessary for growth and reproduction. However, counts of soil organisms vary greatly from time to time and are not a reliable index of soil fertility. The following counts are presented merely as being of interest.

The average bacterial count per gram of soil in 1930 was 1,242,000 for the burned and 857,000 for the unburned areas. In only 1 sample out of 11 did the count on an unburned sample exceed that on the corresponding burned sample. The difference in favor of the burned samples was 385,000 organisms per gram of soil. A larger number of bacteria in the burned soil would be expected in view of the greater amount of organic matter and nitrogen there, as shown by previous analyses. Samples also were collected before and after burning, for the same season. Of 5 sets of samples compared in this way, 3 showed decreases in soil organisms after burning and 2 showed increases. The increases were so great on the two samples, however, that the average increase following the fire was 258,000 organisms per gram of soil.

Coleman (5) has shown that the activities of soil organisms are greatest at temperatures between 86° and 100° F. The average of nine soil temperatures taken to a depth of 3 inches between March 16, 1924, and April 24, 1924, after a 3-year accumulation of plant debris on the unburned area, was 78° for the burned area and 72·5 for the unburned area, or a difference of 5·5° in favor of the burned area. It should be understood, of course, that the temperatures were not taken on or near the days of actual burning, and that the higher temperature was the nearer to the range of optimum temperatures. The results tend to account for the average higher bacterial counts following burning.

DISCUSSION

Although the soil and topography in southern Mississippi vary somewhat from those of other locations in the longleaf pine belt, the growth of grasses may be considered in general as typical for the entire area of well-drained lands. In a region more than 1,200 miles in extent, which once grew one species of tree in almost pure stands, it would be expected that factors influencing the growth of associated grasses and legumes on the forest floor would be nearly constant enough to produce in general a rather uniform herbage growth; and this growth is clearly associated with the effects of centuries of periodic grass fires.

To say that burning the organic matter in the form of plant debris on the forest floor or on top of virgin soils tends to increase the organic matter and nitrogen content of the soil may seem paradoxical. Yet it has been shown that the increase of organic matter in the soil is due primarily to the decay of plant roots and that

incorporation of plant debris with the soil to form humus is an extremely slow process. It is evident also that any factor that increases the number of plants per acre will of necessity increase the formation of organic matter through the addition of roots to the soil, regardless of what becomes of the tops of the plants. In the experiments described the annual use of winter grass fires approximately doubled the growth of ungrazed grasses and legumes per acre over that produced on similar areas completely protected from fire, and caused a corresponding increase in the soil organic matter to a depth of 6 inches.

The soils considered are relatively heavy soils for the region. On lighter sandy soil, where the vegetative growth is much less dense, the reduction in plant growth through fire protection and the subsequent effect on the soil would necessarily be a much slower process.

It has been pointed out that nitrogen in the soil is derived from the gaseous form in the air, principally through the medium of bacteria associated with legumes, and that there is a constant loss of soil nitrogen which must be replaced if the soil nitrogen is to be held in balance or increased. In these experiments the annual use of winter grass fires maintained a legume growth on an ungrazed burned area about twice that on a similar area protected from fire, and the hypothesis seems entirely warranted that this increased legume population has caused a corresponding increase of nitrogen on the burned areas over that on the unburned areas. The difference shown by soil analysis may be due, however, partly to an increase of nitrogen on the burned areas and partly to a loss of nitrogen by leaching from the unburned soils where the current plant growth has been greatly reduced.

In studies of the effect of burning on mineral fertilizing elements of the soil, there was a marked difference in favour of the burned areas. Data obtained on soil moisture showed no significant differences in actual moisture content, but the burned areas produced larger yields of plant growth with attendant larger moisture requirements which evidently were supplied. Data on soil micro-organisms indicate that burning tends to increase their number.

SUMMARY

Analyses of soils taken after 8 years of annual grass burning as compared with complete fire protection on rolling long leaf pine land in southern Mississippi showed 1·6 times as much organic matter in the burned-over soils as in the soils protected from fire. The burned-over soils also contained 1·5 times as much nitrogen as the soils protected from fire. The greater quantities of organic matter and nitrogen apparently result chiefly from roots rather than from tops of plants.

Whether plant debris was burned in place on top of the soil, or was left to rot in place on top of the soil, apparently had no direct effect on either the organic matter content or the nitrogen content of the soil. In both cases, the organic matter and nitrogen above ground were largely lost to the soil and the non-volatile mineral fertilizing elements were returned, leaving organic matter and nitrogen increases to be influenced by the amount and composition of decaying plant roots.

Studies of grass and legume growth on the areas for periods of 8 and 9 years, respectively, showed that the quantity of forage growth on the ungrazed burned

areas at the end of the period was more than double that on the unburned areas. The additional quantities of plant roots decaying in the soil on the burned areas apparently account for the increase in soil organic matter to a depth of 6 inches.

The increased growth, on the burned areas, of native legumes, their ability to take nitrogen from the air, and the additional growth of other plants which take up soluble forms of nitrogen and prevent leaching, apparently account for the increased amount of soil nitrogen.

The increase in organic matter and nitrogen on the burned areas was reflected in the higher crude-protein content of the principal forage grasses that grew on burned areas as contrasted with the unburned.

Annual burning returned the non-volatile fertilizing elements to the soil immediately ; this was shown in the analyses of both the soil and the forage growth.

The increased organic matter and nitrogen in the burned-over soils was reflected in an increased number of soil micro-organisms.

The accumulation of plant debris on top of the soil did not materially increase the soil moisture in spite of the fact that much greater amounts of water were required to support the extra forage growth on the burned over soils.

Organic matter on top of the soil absorbs a portion of the rainfall which is thus prevented from reaching the soil for the use of growing plants.

On the forest floor or on virgin soils, that are not to be plowed, a sharp distinction must be made between the value of organic matter in the soil and organic matter in place on top of the soil.

LITERATURE CITED

(1) ALWAY, F. J.
1928. EFFECT OF BURNING THE FOREST FLOOR UPON THE PRODUCTIVITY OF JACK PINE LAND. First Internatl. Cong. Soil Sci. Proc. and Papers (1927), v. 3, Comn. 4, pp. 514—524, illus.

(2) ———and ROST, C. O.
1928. EFFECT OF FOREST FIRES UPON THE COMPOSITION AND PRODUCTIVITY OF THE SOIL. First Internatl. Cong. Soil Sci. Proc. and Papers (1927), v. 3, Comn. 4, pp. 546—576, illus.

(3) BECKER, R. B., NEAL, W. M., and SHEALY, A. L.
1931. II. MINERAL SUPPLEMENTS FOR CATTLE. Fla. Agr. Expt. Sta. Bull. 231 : 12—23, illus.

(4) CLARK, N., compiler.
1930. FERTILIZER VALUE OF MANURE GREATLY INCREASED BY IMMEDIATE MIXING WITH SOIL. Wis. Agr. Expt. Sta. Bull. 410 : 10—11.

(5) COLEMAN, D. A.
1916. ENVIRONMENTAL FACTORS INFLUENCING THE ACTIVITY OF SOIL FUNGI. Soil Sci. 2 : 1—65, illus.

(6) FINNELL, H. H., and HOUGHTON, H. W.
1932. NITROGEN CONTENT OF RAINWATER. [Okla.] Panhandle Agr Expt. Sta. Bull. 34 : 3—8.

(7) GREENE, S. W.
1929. THE STOCKMAN'S INTEREST IN PROTECTING FOREST AND RANGE FROM FIRE. South. Forestry Cong. Proc. 11 : 52—59, illus.

(8) HARPER, R. M.
1913. THE FOREST RESOURCES OF ALABAMA. Amer. Forestry 19: 657—670, illus.

(9) ———
1915. VEGETATION TYPES. Fla. State Geol. Survey Ann. Rept. 7: 135—188, illus.

(10) HILGARD, E. W.
1914. SOILS, THEIR FORMATION, PROPERTIES, COMPOSITION AND RELATIONS TO PLANT GROWTH IN THE HUMID AND ARID REGIONS. 593 pp., illus. New York and London.

(11) LAIRD, A. S.
1930. A STUDY OF THE ROOT SYSTEMS OF SOME IMPORTANT SOD-FORMING GRASSES. Fla. Agr. Expt. Sta. Bull. 211, 27 pp., illus.

(12) LECLERC, J. A., and BREAZEALE, J. F.
1909. PLANT FOOD REMOVED FROM GROWING PLANTS BY RAIN OR DEW. U. S. Dept. Agr. Yearbook 1908: 389—402.

(13) LOGAN, W. N.
1916. THE SOILS OF MISSISSIPPI. Miss. Agr. Expt. Sta. Tech. Bull. 7, 84 pp., illus.

(14) LYON, T. L., and BIZZELL, J. A.
1918. LYSIMETER EXPERIMENTS. RECORDS FOR TANKS 1 TO 12 DURING THE YEARS 1910 TO 1914 INCLUSIVE. N. Y. (Cornell) Agr. Expt. Sta. Mem. 12, 115 pp., illus.

(15) ——— and BIZZELL, J. A.
1928. NITROGEN ECONOMY IN DUNKIRK SILTY LOAM SOIL. First Internatl. Cong. Soil Sc. Proc. and Papers (1927), v. 3, Comn., 4, pp. 619—627.

(16) MATTOON, W. R.
1922. SLASH PINE. U. S. Dept. Agr. Farmers' Bull. 1256, 53 pp., illus. (Revised 1931).

(17) MERKLE, F. G., and IRVIN, C. J.
1931. SOME EFFECTS OF INTERTILLAGE ON CROPS AND SOILS. Pa. Agr. Expt. Sta. Bull. 272, 19 pp., illus.

(18) MONTGOMERY, E. G.
1911. METHODS OF DETERMINING THE WATER REQUIREMENTS OF CROPS. Jour. Amer. Soc. Agron. 3: 261—283, illus.

(19) PIETERS, A. J.
1927. GREEN MANURING, PRINCIPLES AND PRACTICE. 356 pp., illus. New York and London.

(20) SCHMIDT, H.
1926. FEEDING BONE MEAL TO RANGE CATTLE ON THE COASTAL PLAINS OF TEXAS. PRELIMINARY REPORT. Tex. Agr. Expt. Sta. Bull. 344, 37 pp., illus.

(21) SIEVERS, F. J., and HOLTZ, H. F.
1926. THE SIGNIFICANCE OF NITROGEN IN SOIL ORGANIC MATTER RELATIONSHIPS. Wash. Agr. Expt., Sta. Bull. 206, 43 pp.

(22) SMITH, W. G., and CARTER, W. T., JR.
1904. SOIL SURVEY OF THE MCNEILL AREA, MISSISSIPPI. U. S. Dept. Agr., Bur. Soils Field Oper. 1903, Rept. 5 : 405—418, illus.

(23) STODDARD, H. L.
1931. *THE BOBWHITE QUAIL ; ITS HABITS, PRESERVATION, AND INCREASE.* 559 pp., illus. New York.

(24) VAN HISE, C. R.
1910. THE CONSERVATION OF NATURAL RESOURCES IN THE UNITED STATES. 413 pp., illus. New York.

(*Journal of Agricultural Research. Vol.* 50, *No.* 10, 15*th May* 1935).

INDUSTRIAL POSSIBILITIES OF SOME RESEARCH WORK DONE IN INDIA*

Although, prior to the time of the Great War, efforts at industrial developments in India were not wanting, yet, the phenomenal enthusiasm for the starting of new industries and the serious attempts to explore and exploit industrial possibilities in the country witnessed during the period 1916-18, can be directly traced to the stimulus given to industrial research by the Great War. Since then, the interest has been, more or less, kept up and energetic steps are now being taken by the Central Government to investigate market conditions and centralise research work in industries.

Original work carried out in recent years holding out industrial possibilities, can be reviewed under 5 heads:—(*a*) Researches resulting in permanent factories. (*b*) *Researches resulting in factory operations still in the initial stage,* (*c*) *Researches* resulting in factories operating on a commercial scale, but which for various reasons have been discontinued, (*d*) Researches which have been of proved commercial interest, but which have not been fully exploited, and (*e*) Researches that await commercial consideration.

The researches pertaining to the distillation of sandalwood oil, the utilisation of local oils for soap manufacture, and the manufacture of turpentine may be mentioned as examples which come under the first group. Under the second category comes the manufacture of ceramic wares and gas mantles. Acetone with increased demand under the exigencies of War, may be cited as an instance of a temporary industrial venture. Other industries which may be mentioned in this connection are the manufacture of glue and gelatine, thymol and strawboards. The manufacture of glue deserves careful consideration: a material of a somewhat inferior quality can be produced as a cottage industry and may therefore prove of particular interest to India.

Researches of proved commercial importance, but which have not been fully exploited, deserve special consideration. They concern improvements in large-scale

* Abstract of a course of two lectures delivered by Dr. Gilbert J. Fowler, D.Sc., F.I.C., under the auspices of the Society of Biological Chemists, India, on the 22nd and 26th October 1934.

industries already existing in India. The lac industry is a case in point. It is now faced with competitive synthetic substitutes on all sides, but possesses certain virtues which give the natural resinous product a distinctive character ; the latter, therefore, cannot be easily substituted. This is particularly true in the manufacture of electrical insulators, where the decomposition products of lac which may be formed when exposed to high electrical pressures, are still non-conducting, which is not the case with similarly formed products from artificial substitutes. By imposing a strict scientific control during the various stages of the industry—production, manufacture, storage and transport, and exploiting the by-products of the factory, it should be possible to set the whole industry in order and the natural lac will undoubtedly hold its own against competition.

Another industry, which offers considerable scope for improvement, is the fibre industry. In the year 1931, of the 3½ million tons of coir produced for spinning, only 1/10 million tons were used, and here is ample room for enterprising inventive genius to utilise the waste. The short fibres which can be recovered from the cotton seed appears to be quite suited for paper manufacture, and the pre-treatment of this and other cellulosic materials for paper manufacture demand careful and systematic enquiry. Fermentation or "retting" may be found cheaper than chemical treatment. Other varieties of fibres that are available in India are the *sann* hemp, linseed straw, megasse, rice straw and bamboo.

The problems of the oil industry in its many ramifications are so numerous that there is ample room for continued activity. The proposed Technological Laboratory at Nagpur to be subsidised by the Lakshminarayan bequest intends to take up the subject, and it is hoped that fresh lines of enquiry may be opened up.

The question of power alcohol has been in the minds of Indian technologists for many years, but although the country abounds in exceptionally cheap raw materials, such as mahua, cassava and artichokes whose utility as raw materials have been tested, the production of alcohol has not proceeded much beyond the laboratory trials. Papaya has been shown to contain more fermentable sugar per acre than any other crop in India, and holds out vast possibilities for industrial exploitation.

Another source of natural wealth, which requires only energy and persistence to be utilised with great benefit to the food supply of the mass of the population, is human and animal wastes including activated sludge which can be employed as a starter for composting town and farm refuse, thus yielding a valuable fertiliser.

Other industries whose progress can be ensured by systematic laboratory investigations are the dyeing industry, wood distillation, chromium products, refining of crude saltpetre, preparation of papain and manufacture of vinegar.

A large proportion of the literature that has accumulated concerns those problems which await commercial consideration. To mention only a few, a good deal of work has been carried out on cereals and cereal products, and in the fruit and vegetable industry including its by-products, such as, papain, pectin, tartaric and citric acids, beverages and condiments. With the exception of rose water and sandal oil, little effort has been made to develop the possibilities of perfumes from Indian flowers and scented grasses. The economic handling of the enormous

quantities of molasses from sugar factories, and its utilisation, presents numerous problems awaiting solution.

The argument that, provided raw materials could be exported with profit, it would be unnecessary to spend money in setting up factories to utilise the raw materials and convert them into useful commodities, is illusory since it disregards the importance of the circulation of wealth. There is a considerable field in India, to-day, for small industries requiring comparatively little capital, and no opportunity should be lost to exploit them. The large-scale industries require not only considerable capital, but also courage and vision. A country which has produced Jamsetjee Tata may hope for other captains of industry.

"Ultimately all wealth must come from land since men cannot live without food. In India, it cannot be doubted that every effort should be directed towards a more intensive agriculture..................Improved agriculture should render possible a higher standard of life in the countless villages of India, and with this higher standard a greatly increased demand for the products of mechanical industry."—B. N. S.

(*Current Science*, November 1934.)

CLEANING AND CARE OF GUNS

The following remarks will not apply to the sportsman (?) who drags out his forgotten gun from where it was shoved away at the end of last season, uncleaned, loaded or unloaded, takes a squint down the barrel and pulls trigger; if loaded he will have no use for these remarks, if unloaded he may find a little information of value to him upon the subject of guns, and will remember the very useful motto: "*A loaded gun may go off, an unloaded gun can't.*" *Cleaning* and care of guns is so often looked upon in these days of polished shot and more or less clean powders as a "chore" and unnecessary trouble at the end of a day's shooting irrespective of weather conditions, be it wet or fine. A few will give the barrels a pullthrough with an ill-fitting and dirty plug, wipe off with a still more dirty and ill-smelling rag, take a look up the barrel, get an eye-full of the "brightlights" and say "look at that for a cleanun." What a picture the same barrel would have presented had he looked down from the muzzle end, seen a couple of smeared barrels from lead and spent powder, which in time will cause "pitting."

Cleaning guns is a subject that can be briefly treated. At the end of the day the barrels should be rubbed through with a clean rag or tow soaked in turpentine which removes any leading and dirt, afterwards oiled by means of saturated tow, rags or swab and polishing brush; but at all events use your scratch brush first (which must be tight fitting), then your pullthrough and finish off with clean oiled swab. Gun locks and actions, whether in or out of use, should never be touched with thick oil, as this will collect dirt and become sticky, clogging action, and lock.

At the end of a season the checking of grip and forearm may be scrubbed with luke-warm water and good soap (a good stiff tooth brush is admirable for the purpose); after thoroughly dry, a light oil rubbed in by hand, heel plate and stock may be treated the same way. With a little care and elbow grease your efforts will be

rewarded, to say nothing of the satisfaction one feels when they handle a clean and well kept gun.

To keep a gun clean when laid away and not inspected for months, cover the barrels outside with an equal mixture of best paraffin oil and refined neat's-foot oil, top up the barrels with corks or wads and place inside quarter pint of same mixture shaking it well up and down the interior, then pour back in bottle for further use. Remember that the only method of keeping a gun clean and so preserving it consists in shutting out the air, and consequently the damp. Anything that will do this by remaining on the metal without evaporation will answer. If a gun is in a very bad state of rust and general neglect both inside and out, pour boiling water over the affected parts and afterwards rub in paraffin. After rust and dirt are loosened up wash inside and out with a luke warm solution of good soap-suds, use a rag on end of cleaning rod to form a plunger and pump the suds up and down barrels; thoroughly dry all parts before proceeding to clean in the method described above. Should the barrels be badly leaded some quicksilver rolled up and down inside will amalgamate with the lead and remove it. The silver can be replaced in bottle for further use as often as wished.

Oils and Oiling: Guns to be kept in good condition must be oiled, but only to the extent when the lock and action will "speak" with the pleasant "snick" that tells it is in good working order (a mackerel "soused" may be good, but a gun "soused" in oil is an abomination).

Many excellent gun oils are offered for sale, but beware of cheap oils that contain vegetable oil (for guns). If one will take a little time and trouble, a gun oil that will answer all purposes "lock, stock and barrel" will follow out instructions below, he will have in the finished article a gun oil of the highest quality.

Purified Neat's-foot Oil: (Any quantity in these proportions). Procure half a pint of the best fresh neat's-foot oil; let it stand till all the thick has sunk to the bottom; pour off only the clear or bright part into a bottle: to this add a quarter of an ounce of powdered animal charcoal, shake well and let stand for two or three weeks; strain off into clear white bottle half filled with bright lead shavings; place in a light place, a sunny one if possible, when all the thick and fatty particles of the oil will sink and adhere to the bright lead. It is generally necessary to pour the oil carefully, avoiding all sediment, on to a second set of lead shavings. After a few weeks, when quite brilliant, it may be transferred to small bottles for use, which must be kept well corked.

The above recipe has been handed down for over a hundred years, was originally Chronometer Oil; used by clock makers and adopted for guns by the most famous gunmaker that ever lived—Joe Manton, the first man to introduce the double-barreled gun (Flintlock 1800). (*Illustrated Canadian Forest and Outdoors*, March 1935).

INDIAN FORESTER

MARCH, 1936

A FOREST OFFICER LOOKS AT CHINA

Most foresters know of China as a land in which, owing to a teeming population, the forests have long ago been reduced to small remnants with the result that large areas are subject to devastating floods. They also know that Chinamen used to be easily recognized by their pigtails and the women by the small size of their feet. This was about the limit of my knowledge of China coupled with knowing that a few years ago pigtails were cut off wholesale and that the fashion in women's feet had altered so that the type of foot that has always been fashionable in Patagonia is now also favoured in China. A visit to China, therefore, seemed very desirable to enable one to judge whether one's ideas needed alteration in any respect.

The tourist in China soon finds himself to be just as much an object of interest to the Chinese as they are to him. It does not seem right at first to find one's gaze returned with interest and to discover that on the whole one is rather more of a figure of fun to the local inhabitant than he is to you. A little reflection, however, will show that this is natural. The tourist is one curiosity in the midst of what the Chinaman thinks normal human beings should be. The tourist is forced to divide his curiosity, amusement and interest over most of the landscape and the amount he can spare for any one object or individual must be far less than the amount he receives from one Chinaman and consequently incomparably less than the sum total he gets from the crowds around. The Chinaman views the world through narrow slanting slit-like eyes and consequently gets a peculiar distorted impression. The tourist must make allowances for this and having done so he will soon find that the amusement he causes is all very good-natured. The Chinaman does his best to suppress his merriment until after you have passed him in the street,

and often succeeds in doing so. The women are not nearly so good at hiding their feelings as the men and in certain parts of China audible giggles were noticed when passing any group of women.

I have mentioned that the merriment is all very good-natured which is somewhat surprising since it is well-known that the Chinaman divides the human race into two classes, *viz.* :—Celestials or Chinamen and Foreign Devils or the Rest. The tourist naturally is classed as a foreign devil. The Chinaman is said to be a born gentleman and I must admit that for a foreign devil I was treated pretty well. Only once was I reminded of my status. This was in the railway train. As we pulled into a station, a local train crowded with Chinese appeared alongside. I, of course, was leaning out looking at the strange sights. A small Chinese boy in the train alongside was also looking out. He suddenly caught sight of me and emitting piercing screams fled from the window. His father, luckily, was an educated man and volunteered the following explanation : "The child he fears the foreigner, he no know what foreigner do to him." Foreign devils clearly have their uses in China. Any Chinese child caught smoking opium under the age of 14, showing insufficient respect for his ancestors, refusing to hold his chop-sticks nicely or committing any other offence Chinese children are addicted to, can always be threatened with the foreign devil, who is much more real to them than the bogey man is to Western children.

Since becoming a Republic, China has adopted many things from the west. A few of these are beneficial, at any rate from the point of view of the tourist. As an example I would quote a museum I visited where one could see works of art, previously the property of the favoured few but now open to the general public for a small fee. The objects were well looked after and attractively displayed. There appears to be a special Museums Act and for the benefit of foreigners the main provisions of the Act were translated into English as follows :—

i No smoking is aloud.
ii No confusion is aloud.
iii No compare with the things exhibited is aloud.

iv No photograph and touch to the things exhibited are aloud.

v Care must be taken of the glass of the cases.

vi The exhibition is furnished every day and no close is decided during Sundays, Holidays or the Memorial Days.

Other countries that consider themselves more advanced than China would improve their museums if they copied the second of these rules.

China is of course a vast country and the tourist must not expect to see the whole of it on one short visit, so the following remarks may not apply universally. There are no roads, and communication is largely by junks on inland creeks, which also serve as irrigation canals for lift irrigation, sewers, water supply and many other purposes. The country between the canals is too closely cultivated for roads, but there are many paths about one foot wide. In most countries these would hardly suffice for wheeled traffic but the Chinaman meets the situation by using a special vehicle—the well-known Cycle of Cathay—which is like the wheel of an Indian bullock cart mounted between two boards. At one end of each board is a handle by which a coolie can push and guide the conveyance. The passengers sit on the boards with backs to the wheel and legs hanging down ready to take to their feet when the thing upsets. These wheel-barrows though they certainly can negotiate very narrow paths, have certain disadvantages. A speed of over two miles an hour, more or less, depending on the nature of the soil, is apt to sprinkle mud over the passengers. One man cannot ride, nor can three or any odd number as the two sides must be balanced. I do not know what would happen if a man of 13 stone wished to share one with a wife of 8 stone. In the parts of China where these barrows are in use, there do not appear to be any very fat men, so this difficulty probably does not arise in practice. For goods traffic a larger type of cycle is used, guided by a coolie at each end and drawn on the level or up-hill by a donkey or bullock attached by a very long rope so as to be well clear when down-grades are encountered, as brakes are unknown. Excessive speed is checked by tipping the whole affair over which reduces weight by shedding the load and soon brings the

empty affair to a stop. Any goods worth salvage can be reloaded and the journey resumed. Time is, of course, of no account in China.

Having seen a film called "Shanghai Express," and finding that there really is such a train, I anticipated a little mild excitement on my railway journeys in China. I have no doubt there were plenty of bandits or potential bandits on the train but they had no chance of starting anything. At the wicket of the third class entrance to the station in Shanghai every passenger had to advance with arms raised to be searched by the police. Pistols, daggers, swords or *lathis* were ruthlessly removed and thrown on to a heap at the platform entrance. It was useless protesting that their religion required them to pack a gun. If you wish to travel by train in China you must leave lethal weapons behind and, unlike India, it is also essential to buy a ticket.

All along the railway lines there seems to be much tree-planting going on, almost all of it recent. The Chinaman has long ago discovered that land is far too valuable to be destroyed by turning loose on it hoards of inferior, half-starved goats and cattle. The wasteful system of so-called "free" grazing (that is, grazing paid for and usually paid for heavily by the community) is not practised in the parts of China I saw. The strips of land on either side of the railway are either cultivated or used for tree planting. To some extent they are also used for grazing, but all the animals I saw were tethered, so that they should not ruin two or three times as much as they ate. Waste of any kind seems to be abhorrent to the Chinaman and I doubt if he would indulge in it even if he could afford to do so. The favourite tree for railway planting is robinia followed by willow and poplar.

This article has become so long that I have left no space for an account of the forests of China, but this does not matter as I saw none.

"T. O. H."

GRADATIONS IN THINNING INTENSITY

By R. Maclagan Gorrie, D.Sc.

There appears to be a difficulty generally felt amongst foresters over the exact identification of the grades of intensity of thinning. These grades, commonly designated A to D, increase in heaviness in that order ; A grade is limited to the removal of dead, dying, diseased, and suppressed trees, and " is of no practical value except as a convenient initial stage for further work " ; D grade is classed as a very heavy thinning and includes the removal of all defective and dominated stems, plus such of the dominants " as can be removed *without making lasting gaps in the canopy.*" B and C are intermediate between these extremes ; no mention is made of *any E grade.** Under a separate category are the crown thinnings ; the light crown thinning is roughly correlated with the ordinary or ground thinning grades, being similar to D in its treatment of the upper canopy, but preserving as much of the smaller stems as are required to protect the soil. The heavy crown grade is not directly correlated with any of these ground thinning grades, but if an E grade had been mentioned, would presumably have been linked with it.

In a general sense this classification is widely and successfully applied, but in the close application to individual stands of trees much difficulty arises in its use. Considerable time is spent in fruitless discussions over what actually constitutes a B, C, or D marking. There is perhaps also a tendency amongst senior officers to label as " C grade " what they personally consider a suitable intensity of marking, as this is the most popular classification, and then expect their subordinates to adopt this particular standard as C grade, no matter whether it really coincides with any official standard or not. The position is not improved by reference to the familiar " thinning intensity diagrams " which have appeared with the utmost regularity in silvicultural handbooks, both English and vernacular, and in local forest pocket books. These are excellent for demonstrating

* Classification of Thinnings. *Ind. For. Rec.* XV—I, 1930.

the theory of ground thinnings of the lighter type, but are hopelessly in accurate in their attempt to demonstrate both the heavier ordinary thinnings and the crown thinnings.

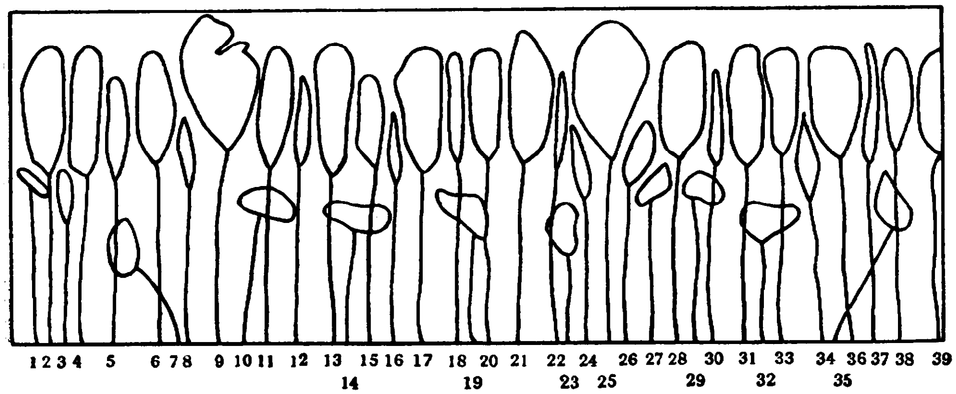
In those diagrams the width of crowns is out of all proportion to the height of the trees, and thus they depict a seriously denuded canopy with the removal of only a few suppressed and dominated stems. A much worse fault, however, is that they show a crown thinning to include the removal of much of the lower canopy provided by the lesser and shorter stems, although this is very definitely against the tenets of a crown thinning, one of whose objects is to preserve these lesser stems unless they are actively interfering with any one of the *élite* stems of the chosen future crop. As an example let us take the series of diagrams shown on pages 111—117 of the U. P. Forest Pocket-book. A light crown thinning is shown as removing trees numbered 1, 3, 7, 9, 10, 14, 18, 19, 20, 23, 25, 27, 29, 31, 32, 35, 36, 37, 39, but I think that in the opinion of most practical foresters a light crown thinning would be better depicted by the removal of numbers 5, 11, 15, 18, 22, 30, 33, 37, 39. In Plate 6 an attempt has been made to illustrate this point, and in Plate 7 a similar diagram for a heavy crown thinning shows the text-book version compared with what is, I think, a more correct interpretation of this operation.

Any form of diagram must of course remain two-dimensional, and herein lies its weakness, because most of our real problems in thinning work arise from the fact that the forest canopy lies in three dimensions. But the fact remains that the errors recurring in the older diagrams have frightened many foresters away from the subject of crown thinnings because these are depicted as drastic operations which cause unnecessary exposure of the forest floor. The object of this note is to show that a reasonably heavy opening of the upper canopy can be made without such exposure occurring, and further to show that the intensity of thinning can now be more accurately gauged than by reference to the text-book diagrams with their accompanying difficulties.

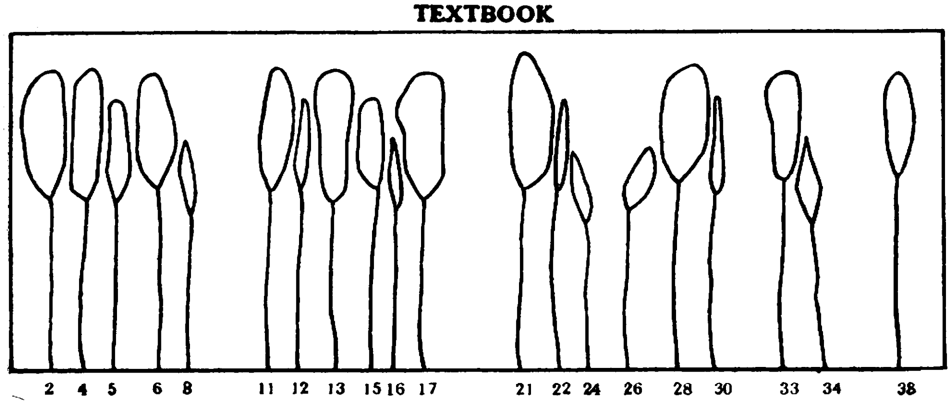
Theorists will hasten to reassure me that there is really no

LIGHT CROWN THINNING

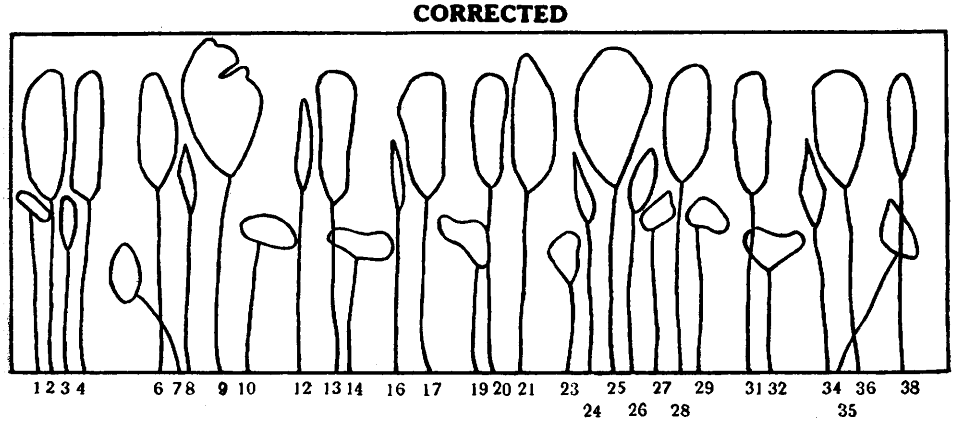
UNTHINNED



TEXTBOOK

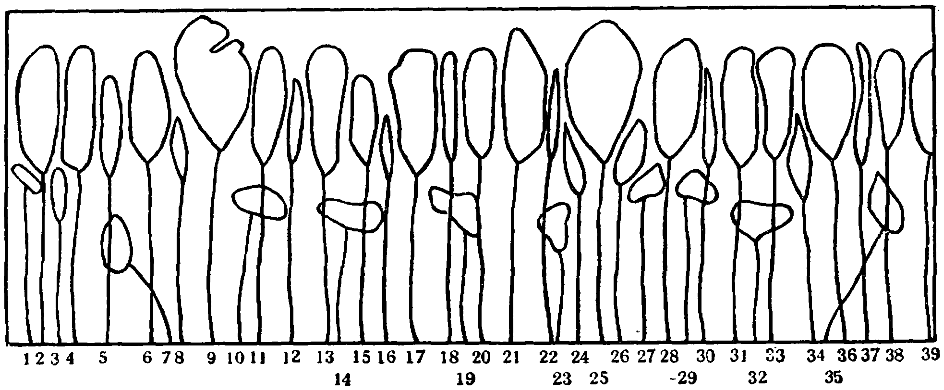


CORRECTED

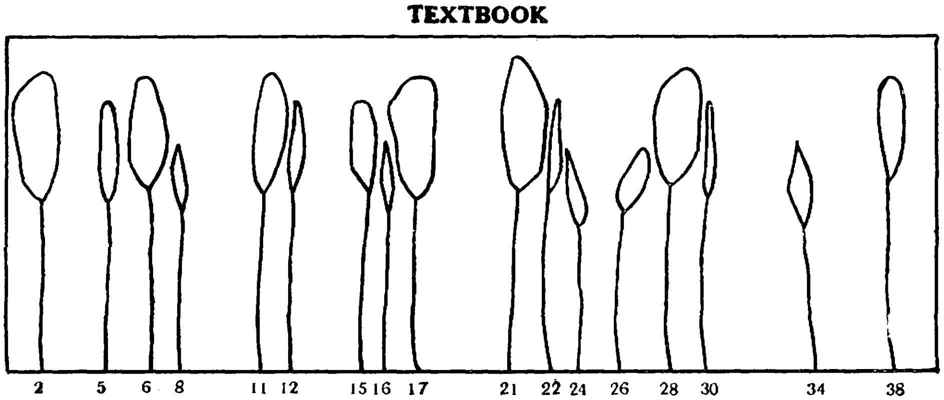


HEAVY CROWN THINNING

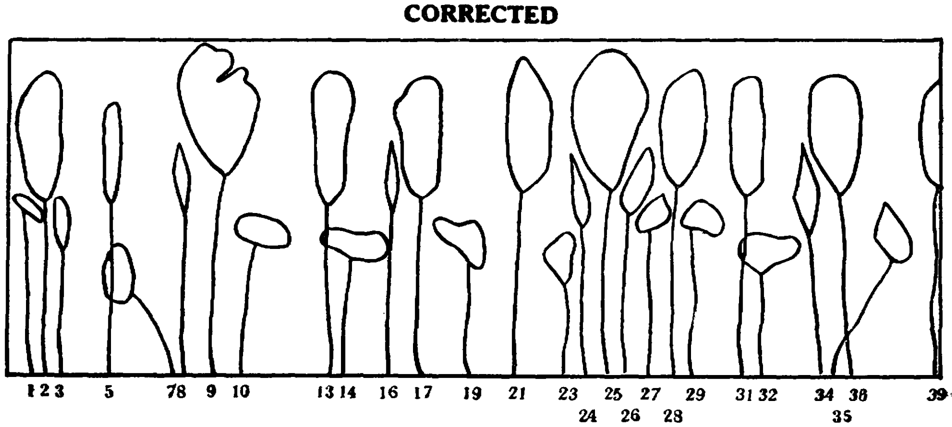
UNTHINNED



TEXTBOOK



CORRECTED



difficulty, because it all depends upon the *basal area per acre*, and that thinning intensities should always be judged and discussed upon this basis. Admittedly this is what we have all been taught by our august tutors, but in actual practice how many marking officers consciously and conscientiously use the figure of the basal area per acre as their yard-stick, either in their own work or in checking the work of others ? I may be maligning our profession, and if so, I hasten to apologise, but I suspect that the answer in this case is *Citrus medica* var. *limonum*, in other words, a lemon ! Each officer makes his thinnings by the light of his own fancy, and if challenged, produces the set of thinning intensity diagrams and proves from them, to his own satisfaction, if not to his superior's, that he is inevitably right !

For those dealing with deodar crops, however, this period of aimless argument should have come to an end with the appearance of Champion and Mahendru's *Multiple Yield Tables for Deodar* (Ind. For. Rec. XV—VIII of 1933), which gives the stocking per acre for every conceivable age gradation, site quality, and thinning intensity that could ordinarily be expected or desired. I find, however, that many workers in deodar have not yet appreciated the accuracy and wide scope for field use of this publication. Having determined the site quality from the height of some mature stems, the measurement on the ground of the number of trees and their average diameter on, say, a $\frac{1}{4}$-acre plot, will immediately give an indication as to which thinning grade between B and E can be applied to the crop, either in its present condition or in any proposed alteration through markings. A further simplification of the picture is to resolve the figure of *trees per acre* into the equivalent figure of *spacing between trees*. This is done in a spacement table (Table 32 of the Record) but it gives one composite figure for all site qualities together, thus giving distances slightly less accurate than can be readily worked out for the particular site quality and thinning intensity under consideration.

Many officers refuse to consider using an E grade thinning, probably because they still retain a mental picture of those horrid old thinning intensity diagrams, which show D grade as a forest

more or less ruined and E grade not even mentioned! A careful comparison of a ¼-acre sample in any average deodar stand with the figures in the table in terms of trees per acre or spacing between trees (triangular spacing), will be proof that an E grade thinning is a perfectly legitimate operation, and one that will vastly improve most woods. As an example, let us take site quality two (top height 100—120 feet at 120 years), and see how the crop is affected by the various intensities of thinning, remembering that the figures are for stocking *after* the thinning has been done, also that in the older age classes they exclude the many lesser stems which would ordinarily be left standing unless they interfere with the crown development of the *élite* trees.

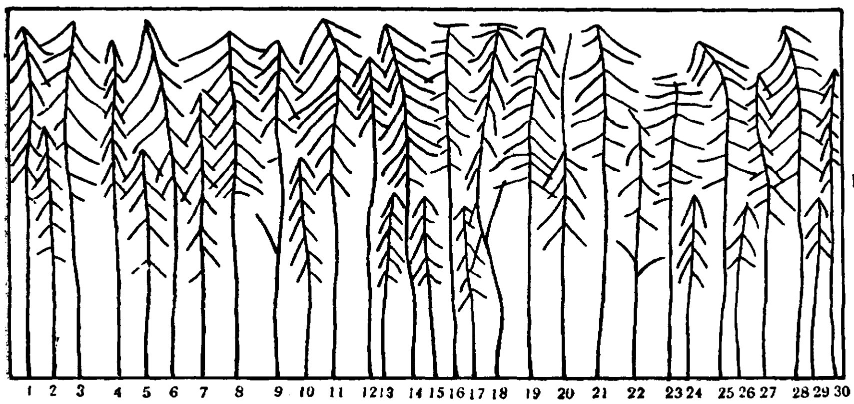
Spacement Table for Site Quality 2 Deodar.

Crop Age.	Average Diameter.		Average Height.		B Grade.		C Grade.		E Grade.	
	B Grade.	E Grade.	B Grade.	E Grade.	No. trees.	Space	No. trees.	Space	No. trees.	Space
20 ..	2·3	2·8	17	20	3,979	3·6	2,994	4·1	1,612	5·6
30 ..	4·1	5·1	29	36	1,745	5·4	1,259	6·3	698	8·5
40 ..	6·0	7·5	43	52	1,004	7·1	730	8·3	391	11·3
50 ..	7·7	9·6	55	67	702	8·5	506	10·0	273	13·6
60 ..	9·3	11·6	66	79	540	9·7	394	11·3	207	15·6
70 ..	10·6	13·3	74	87	460	10·5	329	12·4	171	17·2
80 ..	11·8	14·7	80	93	404	11·2	293	13·1	149	18·4
90 ..	12·8	15·9	85	99	368	11·7	268	13·7	136	19·2
100 ..	13·8	17·1	91	105	336	12·2	245	14·3	124	20·1
110 ..	14·8	18·2	96	111	308	12·8	228	14·9	114	21·0
120 ..	15·9	19·3	102	117	279	13·4	209	15·5	106	21·8
130 ..	16·9	20·4	107	123	257	14·0	193	16·1	98	22·7
140 ..	17·9	21·5	113	129	239	14·5	180	16·7	91	23·5

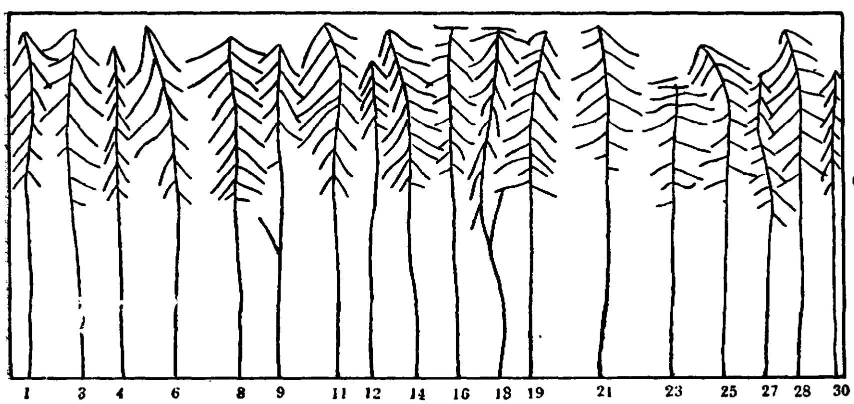
It will be noticed that different diameters and heights are given for the various intensities of thinning for a given age. The striking

SCALED COMPARISON OF C & E GRADES

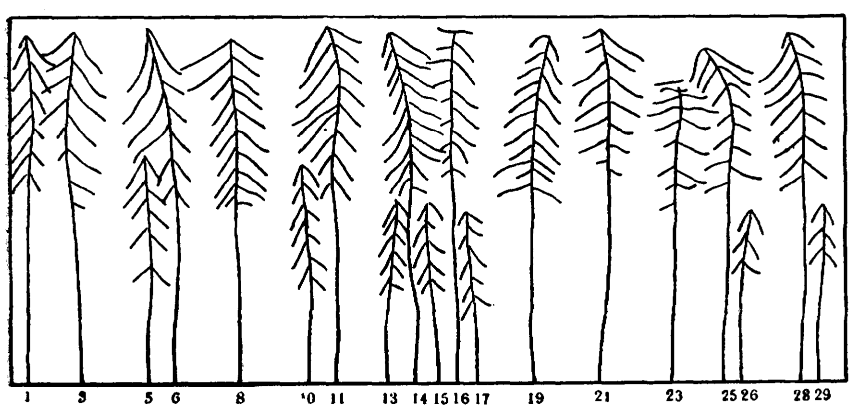
1 inch = 50 feet.



UNTHINNED



C GRADE



E GRADE

increases in diameter and height growth for a given site quality under different intensities of thinning are a feature of Champion and Mahendru's tables, and in themselves form a very strong argument in favour of heavy thinning, particularly when it is remembered that their figures are not empirical curves but are based on many actual sample plots actually thinned to these intensities over a period of several years.

An attempt has been made to reproduce diagrammatically the exact condition of the forest under various intensities of thinning, taking as a sample the figures for site quality two, for grades C and E, drawn more or less to scale as regards spacing, size of crown, and length of bole in Plate 8.

During recent field work for the revision of the Mandi State working plan, which includes over 50,000 acres of good deodar forest, partly in the Sutlej basin, but more largely in the Beas, I have been particularly struck with the obvious need for earlier and heavier thinnings. In the course of field work I have had a number of Pressler's borer samples made to test the current increment. The forests are fairly uniform as regards site quality and mostly fall in quality two (top height 100—120 feet), but they are by no means even-aged, most stands consisting of pole groups with older trees scattered through them singly or in groups, and with younger sapling crops filling up most of the larger gaps. A comparison of the current increment in dominant trees with good long crowns, and in dominant but crowded trees with shorter crowns, shows a most consistent and marked difference. Well spaced trees with well developed crowns half the length of the tree show an average current increment of 7 rings per radius inch, while equally good trees growing under even slightly crowded conditions which have had the development of their lower crown pinched, inevitably show a fall to 15 rings per radius inch.

Further, when the latter type are opened up late in life, they fail to respond to the opening of the canopy around them ; it may take as much as 15 to 20 years before a stem with a previously pinched crown can speed up its growth and take advantage of its new opportunities for development. The large-crowned tree, on the other hand,

will respond at once to any further opportunity it is given. This all points to the need for earlier and heavier thinnings, in order to provide an early and continuous chance for the development of sufficient *élite* trees to make up a fully stocked final crop, plus a good allowance for the inevitable casualties.

As soon as possible after the phase of cleanings in young sapling crops, it is advisable to go to crown thinnings rather than to continue with ground thinnings, and to mark clearly and permanently with a white paint ring the stems which are being selected at this early stage for individual attention as the *élite* of the future crop. Much less material need be removed in the small pole stages if this is done than if ground thinnings are continued, and this is an important point where small material is difficult to dispose of, apart from the obvious advantages silviculturally of retaining as much as possible of the lesser stems as a protective ground cover.

Although the Silviculturist's office has not yet produced as accurate or as full data for other species, one can safely say that these remarks about the advantages of early and heavy crown thinnings apply with equal force to many other species. They certainly apply to all the other Himalayan conifers except the slower growing and shade-bearing firs. *Pinus excelsa* is similar to deodar in many ways though an even faster grower in the sapling and young pole stages, and *Pinus longifolia* we already know to profit greatly by heavy early thinnings applied either with the axe or in the automatic weeding of weaklings which occurs under a controlled burning regime. It would be interesting to know how far a regime of heavy and early thinning would improve the silvicultural treatment of Indian hardwoods; on the basis of recent South African research work, which has shown wattle (*Acacia* spp.) thinnings to be necessary at intervals of months rather than of years, it would seem to apply with equal or even greater force to all the faster growing broad-leaf species.

NOTE ON DR. GORRIE'S PAPER "GRADATIONS IN THINNING INTENSITY"

By M. V. Laurie, *Silviculturist, Forest Research Institute, Dehra Dun*

The difficulty mentioned by Dr. Gorrie in the exact identification of thinning grades by their descriptions and definitions is fairly generally recognised. These grades, however, have formed widely used standards which have given reasonably uniform results throughout extensive tracts of forests in different parts of India and their utility in this respect cannot be gainsaid. If Dr. Gorrie can suggest any other more practical methods of regulating thinnings in the field while marking them it would be very interesting and useful to hear of them.

The tendency among officers marking thinnings to regard their favourite thinning as a C grade is also well known. One comes across many instances of it in sample plot work (where thinnings are supposed to be specially carefully marked). The plots are thinned according to their silvicultural requirements and "C grade thinning done" is noted in the records. Another example is the yield table for the Nilambur Teak Plantations which is recorded as being for C grade thinnings, but is almost certainly based upon a compromise between light crown thinnings and D grade thinnings. This tendency is partly due to the misleading descriptions of thinnings as "light," "medium," "heavy" and "very heavy," respectively, for A, B, C and D grades. One is taught to consider the B grade thinning as "medium" and hence it becomes a sub-conscious standard of a normal thinning and on doing a C grade thinning one tends to think that one is thinning rather heavily, though in actual fact the C grade thinning may have been much too light for the requirements of the crop. This depends upon the species to a great extent as well as on the quality of the locality. A strong shade bearer like *sal* can develop fairly well under light thinning intensities; B grade thinnings are useful while C grade thinnings may sometimes even be considered

as "heavy." If, however, a B grade thinning is applied to most other tree crops in India (*e.g.*, teak, *chir* pine, deodar, etc.), the result is practically no thinning at all because the trees disappear so rapidly after they start to become suppressed. Even a C grade thinning may be "light" for teak or *chir*, and a D grade thinning may be more what is required to be recognised as normal. It is certain that a great deal of damage through under-thinning has been caused by this misleading nomenclature. These descriptions originated in Europe where the thinning grades were first defined, and they were primarily designed for heavy shade-bearing crops like spruce and fir. They cannot, by any stretch of the imagination, be applied indiscriminately to most Indian species which are generally more or less light-demanding, *sal* being a notable exception. It may seem to be sacrilegious, and a casting down of idols from the high places, but it is the considered opinion of the writer that the descriptions "light," "medium," "heavy" and "very heavy," which have been used ever since thinnings were first classified, should be abolished altogether, and thinning grades designated by their letters only.

The definitions of the thinning grades are very elastic, and this is as it should be, since a crop must be thinned primarily according to its silvicultural requirements. Each tree to be removed must be marked according to its condition and its effect on the other well formed dominants that will form the final crop, and the thinning grade definitions used merely as a general guide. For research purposes something more precise is required, and the ratio of basal area/crop diameter is found to give a good measure of the intensity of thinning applied. This, however, cannot be conveniently used in the field as a check on marking thinnings over large areas. Other methods have been suggested for ordinary divisional work such as regulating the spacing between trees according to their diameter but these also are difficult to apply in practice to anything but very young crops owing to the unevenness of the growth and the irregularity of the spacing and crown development once competition has set in. The search for fool-proof methods whereby thinnings of a predetermined intensity can be carried out by inexperienced subor-

dinates has never yet revealed any possible method which does not involve considerable sacrifice of good trees at the expense of bad ones.

Dr. Gorrie criticises the thinning diagrams in the Forest Pocket-book as " hopelessly inaccurate " and complains that the width of the crowns is out of all proportion to the height of the trees. A comparison of the measurements of the two ratios crown width/total height and crown length/total height with actual measurements of trees collected during sample plot work shows that on the average (excluding the suppressed trees which have very exaggerated crowns), the proportions in the diagrams of the 1922 edition of the Classification of Thinnings are fairly accurate, though in the 1930 edition the crowns are slightly too wide on the whole. What is not possible of course in a diagram of this kind is to regulate the spacing of the trees in such a way as to give a mental picture of the density of a three dimensional crop on a two-dimensional page, and although useful for illustrating the crown types and the kinds of trees that are removed in different grades of thinnings, they should not be used as illustrations of the condition of the crop after thinning. As Dr. Gorrie remarks, the impression given is of an open and seriously denuded canopy. The difficulty appears to be insurmountable in a diagram of this kind. Some help might be obtained by the addition of diagrams of a bird's eye or plan view of the crowns in the crops thinned according to the different grades as has been done in Hawley's "Practice of Silviculture " but the only reliable way is to study the crops themselves on the ground.

Another incidental point about these thinning grades is that they are not applicable to young crops in which crown competition and suppression have not reached their full effect. This difficulty has been realised for some years and the matter of drawing up a different classification of thinnings for young crops is now receiving attention.

Anyone can criticise another man's thinning, and even the marking officer himself can pick holes in his own work. All the same it is impossible to agree entirely with Dr. Gorrie's criticisms and

suggested alterations in the crown thinning diagrams. He is right in supposing that all the "m" trees in the diagram may be retained, but being "m" trees (*i.e.*, moribund) their effect in covering the soil will be negligible and transitory. (The thinning diagram greatly exaggerates the size of the crowns of such trees.) Whether they are left or not is of small moment. The Crown thinning definitions are very elastic, and it is possible to suggest several alternative thinnings in the diagrams. It is not possible, however, to agree with Dr. Gorrie's suggestion that the large "wolf" trees (Nos. 9 and 25) should be retained at the expense of dominant trees of better form (*e.g.*, tree No. 11). If this is admitted, Dr. Gorrie's light crown thinning would have to be readjusted throughout and would become very similar to that given in the text-book.

Regarding E grade thinnings, these are omitted from the classification as being probably undesirably heavy in practice, since they practically become crown thinnings without the retention of any of the dominated or suppressed tree classes to fill up the gaps. In an E grade thinning it is almost impossible to avoid making lasting gaps in the canopy which is, of course, not permissible under any thinning grade. E grade thinnings are occasionally made for research purposes in the study of increment (*vide* Statistical Code, p. 226) and the recent Multiple Yield Tables for deodar have included figures and curves for E grade thinnings. These figures were derived from sample plots in which E grade thinnings had been made either purposely for research purposes, or accidentally through snow-break or other causes, or, in one or two cases, through the thinning officer having over-thinned his plot by mistake and finding on applying the basal area check that the result was nearer E than D.

There is a gradual revolution taking place in Europe and elsewhere in ideas regarding the principles of thinning. Gehrhardt's "Schnellwuchsbetrieb" (Management for Rapid Increment) and Heck's Frei edürchforstung" (Free thinnings) are now receiving more consideration. Craib's important work on wattle with reference to the effect of competition and spacing in early youth is also likely to revolutionise o ır ideas regarding the treatment of young crops,

and may also influence thinning methods in older crops. These developments are being investigated and tested in this country and it is probable that in the near future we may have to add several other grades to our thinning classification.

GREAT SNAKES

Despite the writings of such authorities as Kim (in the *Statesman*), Mr. Howard (*Forest Pocket Book*), and Colonel Wall, I.M.S. (*The Poisonous Terrestrial Snakes of India*), there are apparently many points about snakes still unknown to science, which will undoubtedly appeal to the scientific readers of the *Indian Forester*. Little did I realise what terrible creatures there were in India, or how precarious human life must be in this land. Recently, however, a little book ("The Friend in Pocket," by R. S. Dutt Bharaddwaj) fell into my hands dealing fully and faithfully with snakes, scorpions, bites of "mad dogs and rabbits," and such like fearsome fowl, which has opened my eyes and made me despair of ever drawing my pension.

Let us start first with the snakes, of which there are ten deadly varieties. The most deadly is called "Kul Nashak," because "*if it bites a twig, not only will the twig burn to ashes, but also the bush or tree from which it came. Similarly if it bites a man he will die and his relatives will meet the same fate.*" What a cheerful prospect! There are evident advantages in being a kinless loon.

Another snake—the "Agan Jhar"—is so full of venom that "*the grass through which it passes burns.*" A jolly little pet in a fire-protected forest, but what a godsend to the harassed Range Officer when recording that troublesome entry in every fire report—the origin of the fire. To be bitten by this snake is evidently an unpleasant rather than deadly experience, as "*the colour of the body of the person whom it bites becomes bluish, his hairs fall and teeth begin to shake.*" Whether he remains a blue bald body with shaky teeth for the rest of his life or reverts to normal is not stated.

Of the ordinary cobra—"Kala Nag"—we read :—"*Dimensions, Nothing fixed. Length varies from 9 feet to 4 yards or even more.*

Light of lamp becomes dim in its presence on account of poisonous effects on the air about the lamp." Doubtless this explains the rapid increase of hydro-electric schemes in India.

The "*Nag Sankh Raikh*" is a deadly variety. "*Within 10 minutes the person bitten by this snake gets into toxicity and dies after snuffing. If there is any extraordinary heat in the brain on account of his being a celibate or a youth, his brain would become punctured, and the case would go out of control and the patient become incurable.*" I am glad I'm neither a celibate nor a youth anyway. But the most difficult of all to avoid—and therefore perhaps the most to be feared, is the "Nag Tarakana," which, by holding its tail in its mouth "*can jump up two or three yards and then bites a man as far as possible above his belly, and after biting, it runs off very quickly*"—the cowardly brute!

But enough of these horrors. Let us pass on to the correct diagnosis of snake bites. "*Ordinarily the following symptoms are found in a patient bitten by a poisonous snake*:—

Acidity of teeth.

Lividity of teeth.

The patient cannot chew barley corn (No wonder, with such teeth!)

The Sun and Moon will not be visible in their real forms."

There are other symptoms also, but these will perhaps suffice.

Why snake bites should be so deadly or unpleasant is made clear from the following:—"*As soon as the venom of a snake enters the skin, it becomes four times, and when it comes in contact with blood it grows eight times of the original quantity, and in flesh and bones it increases to* 16 *and* 32 *times respectively of the original one. As soon as the breathing is affected, it becomes there* 64 *times and consequently the person suffers from nasal intoxation and dies.*"

Now let us move on to treatment. Fortunately there are many cures for snake bite, too many to detail here, but one or two, which are possibly new to my readers, may be mentioned. "*Recipe No.* 1.—*Dry a frog and make a fine powder thereof by passing the same through a fine cloth. Apply to the bitten part.*" (And if you are not pretty

nippy in getting the frog through the fine cloth, the patient may be dead.)

"*Recipe No. 4.—Peppers washed till their skin is off and their colour becomes white should be dried in the shade. They should then be put in the fresh egg of a pea-hen. The mouth of the egg should then be closed with wax and the egg buried in a granary of rice. When dried it should be taken out of the granary and the contents thereof made into a fine powder and used as snuff.*" What happens if the pea-hen is dilatory over laying the fresh egg is not stated. What a subject for a Heath Robinson picture!

I think we must award the prize for the best cure to the following:—"*Recipe No. 7.—The part bitten by the snake should be excised, and the anus of a hen, after removing hairs therefrom, should be attached to the wound. After ten minutes the hen will be restless; she should not be removed till she is dead. It will cure the patient. This may be repeated if found necessary.*" One might suppose that the process of removing hairs from the specified part would make mosthens distinctly restless in well under ten minutes, but perhaps the hardy Indian hen likes the gentle tickle. Distinctly a line of research for the Forest Entomologist to follow up.

If, despite all these and many other useful recipes, the poor patient dies, the author of the book gives some sage and emphatic advice regarding the disposal of the body—"*I do not hesitate in insisting upon the principle of throwing the dead body in some river, so that there may not be the least possibility of burning or burying a person alive.*"

For which relief, much thanks!

Passing over scorpions, lizards and wasps, we come to "*Remedies against the bites of mad dogs and rabbits,*" which calls up a vision of an elderly and portly D.F.O., or Conservator fleeing before the gnashing jaws of an infuriated bunny. But happy thought —perhaps the *t* should be an *e*?

Finally this excellent little book (price 12 annas, and can be had from "*all booksellers of your town,*") has an invaluable chapter for all forest officers, giving medicines to overcome the effects of excessive

alcohol. Is there a forest officer who will not endorse—"*Recipe No. 7.—Vomiting will also lessen the effects of the intoxication.*"

Let us conclude this brief review with a word of thanks and appreciation to the author who, as he has explained in the preface, "*in commemoration of Silver Jubilee, begs to offer a present to his motherland, India, in the form of this treatise.*" When its heart-lifting merits are fully known it should indeed prove a best-seller.

"S."

HOLY GROVES

By R. Maclagan Gorrie, I.F.S.

The simple faith of the Himalayan hill-folks in the efficacy of their gods is often very striking, and their reverend regard for the old trees which so often grow around their temples should be encouraged rather than laughed at by the forest staff. Where there is little chance of establishing any other type of reserve which will perpetuate such fine examples of tree growth for posterity to admire, we should be grateful that some at least of these fine old trees are securely protected from revenue-hunting marking officers. In most Himalayan temple groves the deodar, being "God's tree," is the most commonly preserved, but where deodar does not thrive, walnut, *Pinus excelsa*, or *Pinus longifolia* are substituted.

An example recently met with is a half-acre of mixed deodar and *Pinus excelsa* in the Brot forest belonging to Mandi State, pictures of which are given in Plate 9. The grove is near the water tunnel entrance of the Uhl river hydro-electric plant, and narrowly escaped being felled during the building of this tunnel a few years ago. The grove was used as a camping ground by Baltis and other imported Mohammadan labour, and the goddess Banbusan is reported to have left the area in disgust, but has since announced her intention of re-occupying the grove now that there are fewer undesirable aliens about!

It consists of two large groups of trees, one mostly deodar and the other kail, with a few fir in both. The measured half-acre contains

Banbusan Devta's Temple grove at Brot, Mandi State, contains some fine deodar trees; the largest 10′ 11″ in girth.

The other end of Banbusan Devta's ½-acre grove contains some good kail.
Photos : R. M. Gorrie.

13 deodar of over 6 feet girth, the largest 10 feet 11 inches, and 14 kail over 6 feet, the largest 9 feet 2 inches. The timber measurement of deodar and kail is 13,000 cubic feet per acre in the round ; this is by no means exceptional and must be surpassed in timber per acre measure by a good many other similar groves, but being so close to Brot rest-house and the haunt of engineers, it is of particular value as a demonstration to the layman of forest productivity.

WHAT ARE THE LARGEST TREES IN THE WORLD?

By Harry D. Tiemann

(*Journal of Forestry*, XXXIII, No. 11, November 1935.)

Records have always had an irresistible attention for the human mind. There are few people, for instance, who are unable to tell you the height of the highest mountain or where the deepest part of the ocean is. Until fairly recently however there was considerable doubt regarding what kinds of trees were the tallest in the world and where they grew, the rival claimants for this honour being the Californian redwoods (*Sequoia sempervirens*) and the Australian Eucalyptus (*E. regnans*). These doubts were set at rest by the investigations of Mr. Lane Poole of Australia, and the figures given in the article under review confirm his conclusions. Incidentally the writer of this article brings out how very unreliable most of the reports of the heights of these forest giants are and what care is necessary in verifying reports and in checking measurements. A number of trees have been reported " on reliable authority " to be over 400 feet high and one even of 480 feet has been mentioned but no authenticated measurements have ever been made of a tree larger than 364 feet, which is at present the world's tallest tree as far as is known. It is, indeed, surprising that the measurements of the world's tallest trees are so unreliable. Though there are certain difficulties in the way of accurate measurement such as difficulty in seeing the top and the bottom at the same time or of allowing for the slope of the ground or the leaning of the tree, yet they are not half as great as the difficulties

a surveyor encounters when he is, for instance, measuring the height of an inaccessible mountain.

The tallest tree in the world at the present time is a redwood tree standing on N. Dyerville Flat, in the Humboldt State, Redwood Park, California, and is 364 feet high. It was measured with a transit by Enoch P. French, Superintendent of the Park. (Mr. Lane Poole's mention of a tree in this locality as 346 feet high in his report on the Tallest Tree in the *Australian Forestry Journal* of the 15th January, 1927, and copied in the *Indian Forester* for September of that year, appears to be a printer's error, since another tree of larger size is mentioned as an "also-ran.") Another redwood tree located on Bull Creek Flat, at the junction of Bull Creek with the South Fork of Eel River, was measured by the same party in 1930 as 361 feet high. This is presumably the same tree as that mentioned by Lane Poole as having been measured by a party under Mr. David T. Mason on 28th March, 1926, as being 359 feet high when measured from one direction and 368 feet high when measured from another direction, using a transit in each case. Much difficulty was experienced in measuring this particular tree because the top could only be seen from a position rather close to the base. There are a number of other living redwood trees over 320 feet high which have been measured.

A Douglas fir tree which grew in Seymour Valley at Vancouver, B.C., and was felled in 1895 is reported to have been 417 feet high with a clear bole of 300 feet to the first branch. The report is well substantiated from a number of sources but has been much questioned. If true, however, it establishes the Douglas fir in former times as one of the largest trees in the world.

There are several reports of trees of *Eucalyptus regnans* (Mountain Ash) in Australia that are supposed to have grown over 400 feet in height, but none of these have been authenticated. One tree called "The Baron" was alleged to be 464 feet high, and a photograph of it was exhibited at the Melbourne Exposition in 1888, but subsequent measurement by a government surveyor showed it to be only 219¾ feet high! This shows how far such "reports from a reliable authority" can be trusted. The tallest properly authenticated

measurement is of a "mountain ash" tree at Colac 347 feet high, and there is a very plausible report of another tree two miles from Thorpsdale in Gippsland which was said to have been measured as 370 feet when standing and verified as 375 feet when felled after allowing for the stump. Unfortunately this is a report from memory and cannot be fully substantiated. All these trees, however, are now no longer living and it is doubtful whether there are any Eucalyptus trees over 300 feet high alive to-day. The Californian redwoods, therefore, are the tallest living trees by some 50 feet or more.

It is of some interest to compare India's largest trees with these giants. India has never figured with reference to trees of outstanding dimensions and many of the trees mentioned below, most of which are conifers from the Himalayans, have been felled or disappeared since they were measured :—

Cedrus deodara	.. 240 feet high—Sutlej Valley
	240 feet high—Kulu Dungri Temple Grove
Picea morinda	.. 215 feet high—Jaunsar (Mundali)
Abies pindrow	.. 206 feet high—Jaunsar (Mundali)
Abies pindrow	.. 202 feet high—Jaunsar (Mundali)
Tectona grandis	.. 192 feet high—S. Malabar
Pinus longifolia	.. 180 feet high—Tons Valley, Chakrata Division
Pinus excelsa	.. 165 feet high—Kashmir
Shorea robusta	.. 161 feet high—Bengal

The tallest known Indian trees thus fall short of the world's record by over 120 feet.

Diameters or girths, though more accessible for direct measurement, are difficult to compare accurately on account of variations in the height of measurement and irregularities due to basal sewelling, buttresses and so forth, not to mention trees that fork so low down as to be doubtfully compounded of two or more trees that have fused together. A chestnut tree (*Castanea sativa*) at the foot of Mount Etna holds the world's record girth of 190 feet (measured in 1780)

and 204 feet (measured in 1836). It is still living, but has broken into 3 separate fire-scarred but vigorous pieces.

The redwoods though tallest have by no means the largest girths. Two *Sequoia gigantea* standing in the Sequoia National Park called General Sherman and General Grant have mean diameters of 24 feet each at a height of ten feet from the ground. These appear to be the largest living trees of their kind though there are reports of larger ones that have since disappeared ; thus Mr. Tiemann mentions a tree in the Calaveras grove felled in 1853 with a diameter inside the bark at six feet from the ground of 25 feet. (The bark was 15—18 inches thick.) Forty-nine people danced on the stump. The passing of such a magnificent tree should have been an occasion for mourning rather than jubilation.

The greatest authenticated record girth of *Eucalyptus regnans* in Australia is the tree called " King Edward VII " near Marysville, Victoria. It was 25½ feet in diameter, 10 feet from the ground, and was alive in 1918, but is now dead.

A Kauri tree (*Agathis australis*) of 24 feet in diameter is mentioned, which is phenomenal since there is no root swelling and Kauri has a form factor of approximately 1·00 ! It had a clear bole of 80 feet. Another of 22 feet diameter and 100 feet clear bole is also mentioned.

There are a number of other species with greater girths than those recorded above, but they usually have short branched or bloated trunks (*e.g.*, *baobab* and *banyan*), and are consequently less impressive.

For sheer volume of bole the Kauri tree " Kairaru " of 22 feet diameter mentioned above, containing 31,416 cubic feet inside the bark below the first branch, and the redwoods (one is mentioned of containing 361,366 board feet or 30,114 cubic feet of timber), hold the record.

Ages have been reported up to 6,000 years, but it is doubtful whether anything over 3,500 to 4,000 years can be substantiated.

As regards Indian trees, again the largest girths are very considerably smaller than the world records. The reports of excep-

tionally big girths are compartively few, the largest at present known being as follows :—

Cedrus deodara	.. 31 feet 6 inches at 6 feet—Bashahr, Punjab.
Abies pindrow	.. 21 feet—Kashmir.
Teak	.. 26 feet 7 inches—Pahok, Burma.
Shorea robusta	.. 25 feet 8 inches—Ramnagar, U. P.

It is quite probable, however, that larger trees may exist which have not been reported.

M. V. LAURIE, I.F.S.

A FURNACE KILN FOR TIMBER SEASONING

By S. N. Kapur, Ph.D., A.M.I. Chem. E.,

Officer in Charge, Wood Seasoning Section, Forest Research Institute, Dehra Dun.

In the process of seasoning wood, a lot of superfluous moisture has to be got rid of by evaporation, for which purpose a supply of heat to wood is necessary. The usual source of heat in kiln-drying of wood is steam, generated in a steam boiler, which is used for heating air to be circulated in the kiln. Although the use of steam for kiln-drying of wood possesses certain distinct advantages, yet there are instances in which the installation and upkeep of a boiler are too costly, on account of the small and irregular output of some factories, the provision of a trained staff for the boiler in accordance with the local boiler regulations, and sometimes difficulties due to municipal bye-laws. As most of the wood-working industries in this country are carried out on a small scale, it was considered desirable to experiment at Dehra Dun with some simple types of seasoning kilns in which the necessity of a steam boiler is avoided.

There are two methods by which smoke from burning wood fuel can be used in a kiln, either in a direct manner by passing it into the drying chamber and allowing it to come in contact with the wood to be dried, or indirectly for heating air to be circulated in the kiln. In the first instance, a study has been made of a furnace kiln supplied by an Austrian firm, which is based on the direct use of the furnace gases for drying wood, the smoke being subjected to a second firing, where it is more or less completely burnt, before it is blown by means

of a fan into the drying chamber. The results with this kiln so far have been very successful, and a detailed account of the construction, operation and working of the kiln is being published in *Indian Forest Records*, Utilization, Vol. I, No. 3. A brief summary of the results obtained is given in this note.

The furnace is designed to burn waste wood fuel, such as branch wood, slabs, off-cuts, shavings, chips or sawdust, and under normal conditions of operation requires about eight maunds of fuel daily. The kiln has a capacity of about 200 c.ft. of sawn timber to a charge and the average time required for drying green hardwoods such as mango, toon and white chuglam in one inch thickness, can be reckoned at about 7 to 10 days. The kiln is worked on an intermittent process, the furnace being operated for about 8 to 10 hours daily. The fan is allowed to run for a few hours longer, and there is a total stoppage of the kiln for at least eight hours during the night. One operator is sufficient to look after the kiln, and as the method of operation is fairly simple, a semi-literate labourer can be trained to do the work. The consumption of electric current is about 20 to 25 units per day. In a number of charges that have so far been tried in the kiln, the rate of drying has been as rapid and the condition of dried material as good as those obtained in a steam-heated kiln, except for a certain amount of surface-blackening of the wood, due to unburnt smoke passing into the kiln, but the effect is only superficial and is entirely removed by light planing.

It will be seen that if the cost of fuel is negligible, as in the conversion and manufacturing processes sufficient amount of waste wood is obtained to operate a kiln of this type, the cost of drying would be confined to the pay of the operator, interest and depreciation on the plant, and the electric current consumed. For furniture manufacturers working on a small scale, and for small sawmills, this type of kiln would be particularly useful. Enquiries are invited from those interested in this kiln, which should be addressed to the Forest Economist, Forest Research Institute, Dehra Dun, who will be glad to furnish detailed information about the construction and operation of the kiln.

DAMAGE BY FROST AT NEW FOREST, DEHRA DUN, DURING 1930-34, FOREST BULLETIN No. 91

BY BACHASPATI NAUTIYAL

Foresters interested in nursery and plantation work in Northern India should find that the observations and conclusions recorded and set forth in this bulletin will well repay their careful perusal.

It may perhaps be wondered whether the title "Damage by Frost" is the most appropriate that could have been given to it. For it is rather a striking feature of the bulletin that not one of the low temperatures recorded in it as having damaged or killed young teak in the New Forest demonstration area is as low as freezing point. Chilling, rather than actual freezing, might thus appear to have been the lethal factor.*

The investigation indicates how serious can be the chilling effect on nursery beds and young plants if they are continuously "protected" throughout the winter days and nights by natural or artificial shelter. It shows indeed that it is far better not to shade at all than to do it continuously by day and night, a fact to which it

---

*In view of the fact that despite constantly recurring frost damage, the officially published Meteorological records for Dehra Dun never record temperatures below 32° F., the daily records at the Forest Research Institute have been supplemented at the Silviculturist's request by minimum temperature readings on the surface of the ground at the meteorological station. There has been occasional trouble with the instruments, so that the record is not a continuous one, but in December-January, the reading is generally 4° to 10° below the minimum on the screen (4 ft. above ground level). In January 1933, for example, the readings were nightly below freezing between the 4th and 10th and again between the 27th and 31st. The lowest figure appears to be 25·2° on the night of January 31st. 1934, when the screened thermometer read 32·3°, also the lowest record during the period in question.

may perhaps be doubted whether most of us are fully alive, although it seems obvious enough when pointed out that the warming effect of the sun in the daytime must to some extent help to keep up the temperature of the soil at night.

The observations also shew, and explain why it is, that young plants on the northern side of a wall, or a hedge, or a belt of trees, may suffer severely from cold while those on the south are undamaged. Other aspects too are touched upon, such as the relations of soil moisture and the period of plant activity to the cold spell, which are probably of special significance inirrigated nurseries and plantations.

All foresters who are troubled by frost damage, or by what they believe to be frost damage, to nurseries and young plantations, would do well to study this bulletin. Ranger Bachaspati Nautiyal is to be congratulated on a useful and suggestive contribution to our knowledge of a subject about which some of us have perhaps been cherishing a few wholly erroneous beliefs.

R. G. M.

EXTRACTS

SOWING CROPS BY AEROPLANE

By Frank Miller

The success of last year's aerial reseeding operations in checking soil erosion on 10,000 acres of burned-off land in the Santa Barbara National Forest promises to open a new source of revenue for the independent operator.

The first seed sown by aeroplane in the Santa Barbara National Forest, for erosion control, was in 1932. The 1932 project, which was very successful, was undertaken as an experiment. Likewise, last year's project was successful, but the operation was still considered to be in an experimental or development stage. Both the past operations were scientifically conducted and checked and it was found that it is still desirable to experiment with possible improvements.

The contract in 1932 was given to Paul Mantz, who had a galvanized-iron hopper made to fit into the front cockpit of his aeroplane. The bottom of the hopper, which

completely filled the cockpit, sloped in from all directions to an opening running crossways of the ship. The hopper fitted into a funnel which carried the seed through the floor. A valve consisting of a sliding plate between two fixed plates opened or cut off the flow of seed. This sliding plate was operated by a lever from the rear cockpit so that the quantity of seed leaving the hopper could be controlled in flight. The valve dumped the seed into a tube located under the plane in the propeller slip stream.

Four days were required to sow the 18,000 pounds of mixed mustard and clover seed that were distributed over the 2,000 acres included in the project.

Tests were run by flying the plane over long strips of burlap at various altitudes and releasing seed while flying over. After each flight the burlap was swept clean of seeds and the seeds were weighed. The best distribution was obtained from an altitude of 300 feet. Seed was then dropped on the packed beach sand from 300 feet, and it was found that the seed's penetration of the sand, which was up to depths of ¼ in., was not injurious to the seed.

To efficiently sow seed on 2,000 acres of land that varied in altitude as much as 4,000 feet was quite a problem, particularly when it was to be sown from a constant altitude of 300 feet. A straight line flight was not practical. The procedure finally followed was to fly the contours, finishing one canyon at a time. Thus a constant altitude could be maintained, and it was relatively simple to keep track of the area that had been covered. Approximately 450 pounds of seed were carried so that about fifty acres were sown each trip.

Cheaper and Quicker

The cost of seeding the Santa Barbara area by air was 70 cents. per acre against $1·30 by hand.

Although sowing seed by aeroplane was less expensive than by ground methods, this was not the prime reason the areas in the Santa Barbara National Forest were sown by plane ; it was rather the time element that was the deciding factor when the contract was issued. The unemployment situation made it desirable for the government to use hand labour, but the limiting factor of time made it impossible. If the seed were not sowed before the first season's rains, erosion would set in, and much top soil would be washed away. Hand sowing was slow, a crew of several men and a foreman could only sow from four to ten acres per day. The lack of roads and even trails, hard climbing and lack of water in some of the back country made it difficult to get the crews in, and when they were in, it was hard for them to work.

On the other hand, by using an aeroplane, 1,250 acres per day could be sown and the entire job finished before the rains.

Although operations are open to a few improvements, the efficiency of reseeding by airplane over ground methods has been established. A couple of operators in the North-west have specialised in reseeding logged-off timber land for grazing purposes with a great deal of success, and now a branch of the government has recognised its value in the control of soil erosion. (*Air Review.*)

AN ENDURANCE RECORD

On 28th February, 1928, the Far East Flight of the Royal Air Force, which consisted of four "Southampton" type flying boats, landed on the Straits of Johore, opposite what is now the R. A. F. Base. The aircraft had flown in easy stages from England, making a survey of the route, and we were anxious to get them hauled out of the water so that we could examine the hulls, superstructures and engines and discover the ill-effects, if any, of four months' flying under a diversity of sea and climatic conditions.

At last, early in May, we were ready for our test flights, but where one of the boats (S.1151) was concerned, we were confronted with a dilemma. On the underside of the top plane, and securely fastened to the top of one of the struts, a pair of swallows had built their nest. They had worked swiftly and silently, and not until the nest was completed was its presence noticed, and we concluded that it must have been built during the four or five days' leave we had had prior to our final tests before leaving for Australia.

A council of war was called, but no one had the heart to suggest that the nest should be taken down, and we therefore decided to leave it and hoped that the young would be old enough to be moved before the day of our departure, three weeks ahead.

Then came the problem of the test flight. When the engines were started, the mother left the nest in a panic and flew round and round until they were stopped, when she at once returned and re-entered her home. The engines having run satisfactorily, the following day the boat was launched, taken out to its moorings, and the engines again started. Out came the bird once more and flew excitedly around until the flying boat took off on its test. When it had disappeared from view, Mother Swallow flew round the other boats still on the slipway, going up and examining the corresponding strut on each in turn.

After an hour S.1151 returned and was made fast to its moorings, and within a few minutes of the engines being stopped the mother was again inside her nest. Since the previous day, Father Swallow had not been seen, nor did he ever return to the nest again. Mother, however, seemed all the more determined to bring up her young, and, apart from a sortie early in the morning and another in the evening, remained at her post of duty, and seemed quite undisturbed at the new location of her home out on the water.

At last the day for our departure drew near, and at 5 a.m. on the morning of the 21st May we started our engines before it was yet light. The crew of S.1151 watched to see whether the swallow would leave her nest, but on this occasion she decided otherwise, and, shortly before 6 a.m. we all took off and set course for Sumatra, S.1151 still bearing its strange burden. We crossed the Equator at 7-30, and two hours later we alighted at Klabat Bay in Banka Island, where we were to remain as guests of the Dutch inhabitants for two days.

Our moorings were some 300 yards from the shore and approximately 200 yards apart, and, after completing refuelling the crews went ashore. I and my engineer were on "duty," and just before dusk, whilst we were slinging our hammocks on the

deck, the swallow appeared and kept flying up to the top of the strut on our boat corresponding to the one on which was her nest. Although the strut was bare, she kept returning time and again until at last, just before dark, she disappeared in the direction of her own boat and, shortly after, we received a signal from the duty engineer of S.1151 that she had returned to her nest.

The next day she was seen bringing food to the nest and apparently none the worse for her long flight of the previous day. The following morning, however, we were due to leave for Batavia, the capital of the Dutch East Indies, and before the sun had risen we were high above the jungle, rice fields and beautiful coastline of Southern Sumatra, with the swallow family once more having their residence moved. At 8 o'clock we left the Sumatra coast and set our course for Java.

Although the weather was fine, a fresh wind of about 25 m.p.h. was raising a very choppy sea, and just before 9 o'clock we saw smoke pouring from the cockpits of S.1151, which was flying about a quarter of a mile away. Almost immediately the engines were throttled back and, to our relief, we saw her land safely, though after a heavy bounce. It transpired that one of the accumulators had caught fire, filling the boat with acrid smoke and forcing the crew to alight to prevent their being suffocated. The faulty accumulator was soon thrown overboard, and, after a short but severe hammering from the rough sea, the boat once more joined us and we reached Batavia, the flight from Banka having taken five hours.

But what of our friends, the swallows? They had been quite forgotten in our anxiety over the forced landing, and it was not until we had completed our mooring up that we realised that they had been on the unfortunate boat. We launched our collapsible dinghy and pulled over to S.1151 to make inquiries. Much to our sorrow, we found that the forced landing had done what a 90-mile-an-hour rush of air under the planes had been unable to do, and that the nest had completely disappeared, leaving no trace of itself or its occupants except some small pieces of mud which still adhered to the top of the strut.

We decided that the impact of landing in the rough sea must have destroyed the nest, but that, although we were afraid the youngsters had perished, the brave mother had probably reached land safely, as there had been several islands in sight.

Surely an extraordinary case of devotion on the part of a bird, that it should thus stick to its young despite the loss of its mate, and what must have been to her the terrifying experience of being flown long distances through the air to the accompaniment of the roar of 900 horse-power within a few feet of her nest!

(*Air Review.*)

FEATURES OF A "HOME-MADE" WATER-DRIVEN SAW MILL

Occasionally one comes across curious examples of woodworking machinery and shops, saw mills, etc., and in this connection *The Malayan Forester* contains a brief description, by Mr. C. L. Carrier, of a water-driven saw-mill erected by an enterprising permittee in the Ulu Selangor district. Built on the banks of the Sungei Liam, a boulder-strewn stream 15 to 20ft. wide, with a swift flow, the permittee,

Woo Chin, took about three months to complete and equip the mill, the cost of which, machinery and labour, totalled $831·77.

Mr. Carrier writes that a small dam of large stones and boulders has been erected at a suitable spot across the stream in such a way that flow is not obstructed. Just inside the dam the river forms a shallow pool. A channel brings the water, which is controlled by an ordinary wooden "gate," to the mill, where it flows through a wooden trough on to the water wheel. The edge of the trough is slightly behind the vertical axis of the wheel and about 2ft. above it, so that the water rushing through hits the wheel "full in the eye," so to speak.

The wheel itself is built solidly of chengal and meranti (*Shorea* spp.) and is 12ft. in diameter, with 48 boxes on its periphery. The shaft is of wood, at each end of which is inserted a solid bit about 2in. in diameter, and it is on these that the wheel turns, the two main bearings being just two U-shaped strips of metal inserted into two large wooden beams. Constant and cheap lubrication is maintained by means of two split bamboos with internodes removed. These carry water to both bearings.

On the same shaft as the water wheel, there is carried a pulley wheel, also of wood, 10ft. in diameter, connected by means of canvas belting to another, 2ft. in diameter. This latter drives the countershaft, which carries a flywheel of 8ft. diameter and another pulley 6ft. in diameter, the whole being constructed of merbau timber. The countershaft runs on ball bearings which are mounted on two stout blocks of timber. The whole thing has been constructed and aligned so well that there is barely a sign of vibration anywhere.

The pulley on the countershaft is belt-connected to that on the saw mandrel, which was purchased locally. The saw spindle revolves in ordinary bearings, mounted on a cast iron base plate which is bolted to the saw bench. With a medium flow of water the saw attains a speed of between 5/600 revolutions per minute.

The saw used at present is of the solid tooth circular type, 24in. in diameter; but Woo Chin has another of 36in. diameter which is also used occasionally.

The saw bench itself measures 6ft. × 4ft. and is about 27in. high, constructed mainly of chengal, with a feed roller of the same timber at each end It is hand-fed, but a drag feed motion has lately been incorporated in the design to simplify the work of hand feeding. This consists of a long rope with a hook at one end. The other end of the rope is wound round a simple wooden windlass which is placed behind the saw, and this is operated by hand. The timber to be sawn is placed on wooden rollers on a separate frame before the saw; the hook at the end of the rope is fastened on to the edge of the timber farthest from the saw, and the windlass is revolved slowly, dragging the timber towards it.

An adjustable fence or guide is provided to ensure straight cutting, but it appears to be not long enough. By means of a graduated scale marked out on the bench, this can be set so as to cut pieces of any thickness, without having to measure with a rule.

Only small dimension stock and boards up to 10in. in width have been cut up so far, and all of this has been disposed of in the local market.

When the saw runs hot it is cooled by spraying water on to it. This is done by a coolie with a can, but this means the waste of a pair of good hands, and Woo Chin will soon be installing a bamboo pipe to bring water to the saw.

Another useful addition proposed will be an automatic drag feed worked by pulleys and gears, with a dog clutch, probably from some old motor-lorry, for engaging and releasing. This will be completed soon. A defect that is apparent is that the fence or guide, to ensure straight cutting, is not long enough ; or probably another adjustable one is required on the opposite side of the saw. Perfectly straight cutting has not yet been achieved, but this can probably be corrected by installing a longer guide, and certainly by ensuring that at least one face of the timber to be cut up is perfectly straight.

Woo Chin intends installing a second saw bench, with a circular saw of larger dimensions, for breaking down large logs.

(*Timber Trades Journal*, 15th December 1924).

VENEER AND PLYWOOD

For veneers and plywood, some of the hard tropical timbers, often showing beautiful colouring and figuring, are becoming better known. Research on wood for veneer and plywood has been carried out for some time at the Research Institute at Dehra Dun. In Indian Forest Records (Economy Series, 20, 14. Delhi : Manager of Publications, Dec. 1934), Mr. W. Nagle, who is in charge of the Woodworking Section, discusses the "Testing of Indian Timbers for Veneer and Plywood." The purpose of the monograph is "to assist, as far as possible, the advancement of the plywood industry in India, and to further the use of indigenous timbers for veneer and plywood work."

Only those who have followed the development in the use of plywood during the last two decades will have a conception of the variety of purposes to which it is put at the present day. The author reminds the reader that the art of veneering was practised by, and certain forms of laminated construction were used by the ancient Egyptians. But in Great Britain and for many centuries in Europe, solid wood was used both in house construction and for furniture. Modern demands for luxury articles at a cheap price have assisted and encouraged the use of plywood ; but it would be misleading to think that the great demand for this material has been the result of any consideration for the conservation of valuable timbers. The truth is that at the present day every country which possesses areas of forest containing valuable that is, luxury timbers is, by means of research work and otherwise, endeavouring to place them on the world markets.

It is well-known that plywood has come into use in the manufacture of furniture and panelling. But it is worthy of placing on record the following list of other articles which are nowadays formed or built out of this fabricated material: cabin trunks, suit cases, perambulators, and even musical instruments such as violins and mandolins are made of either veneer or plywood. The modern motor-car has considerable amounts of plywood in its make-up, for example, floor boards, hood-stays, body-work, roofing and panelling. Other plywood or veneered articles in

common use are chairs, theatre seats, wall panelling and ceilings, screen scenery and stage buildings for the cinema industry and theatres, railway carriages, dining saloons and "sleepers." The modern ship is fitted with plywood tables, bulkheads and general appointments. Parts of motor-boats, canoes and life-boats are often constructed of the same material; also aeroplanes and airships. Finally, chests are now made for tea, opium, cement, rubber, etc.; as also fruit and cigarette boxes.

It will be obvious that the above list is capable of indefinite extension. That it has reached its present dimensions gives evidence of the considerable amount of research and experimental work which has been carried out during the past few decades.

Mr. Nagle's monograph is based on research carried out during the past ten years with Indian timbers, upon which little was known as to their suitability or otherwise for veneers and plywood. It is technical in character, with a number of interesting photographs, and deals with some forty-two Indian timber trees.—(*Nature*, 31st August, 1935.)

SUMMARY OF THE WORKING PLAN FOR THE KALIMPONG FOREST DIVISION, BENGAL, FOR THE PERIOD 1934-35 TO 1943-44

The principal prescriptions of the Plan, are as follows :—

I.—THE TISTA WORKING CIRCLE

Silvicultural system.—Conversion-to-Uniform by clear-fellings followed by regeneration by *taungya*. Areas not taken up for conversion during the next ten years will be worked under the selection system.

Exploitable size.—A girth of 6 feet 6 inches over bark.

Rotation.—The species proposed to be grown attain the exploitable size in 45—60 years. The rotation or conversion period is fixed at 60 years with 6 periods of 10 years each.

Periodic Blocks.—Periodic Block I is laid down so as to contain 1/6th of the total cultivable area in the whole Working Circle. Periodic Blocks II to VI remain unallotted and contain areas already regenerated and old forests not included in Periodic Block I.

Yield.—By area. In Periodic Block I one-tenth of the cultivable area will be clear-felled annually, in Periodic Blocks II to VI selection fellings will be carried out annually on one-twentieth of the old forests.

Felling rules.—Periodic Block I.—Fellings will be made on the sequence given and will proceed downhill. Small cultivable areas on precipitous slopes and small precipices in large blocks of cultivable area to be left unfelled, but the latter to count against the yield of the year. Non-cultivable areas may be worked under the selection system to meet abnormally high demands.

Periodic Blocks II to VI.—Selection fellings on purely silvicultural grounds and subject to the maximum of 1/20th of the old forests and to follow the sequence given.

Dead and fallen trees may be removed from anywhere at the discretion of the Divisional Forest Officer.

Subsidiary regulations.—The species to be grown are *gokul* (*Ailanthus grandis*), *panisaj* (*Terminalia myriocarpa*), *chickassi* (*Chukrasia tabularis*), *toon* (*Cedrela toona* and *microcarpa*), *angare* (*Phoebe hainesiana*), *labshi* (*Polyalthia simiarum*). Experiments are to be carried out with *gokuldhup* (*Canarium sikkimense*), *khanakpa* (*Evodia meliaefolia*). Climber-cutting in old forests is to be done with Selection marking. Clear-felling coupes are to be surveyed one year after felling. Jhoras are to be fixed by planting bamboo suckers.

II.—THE SELECTION WORKING CIRCLE

Silvicultural system.—Selection fellings combined with improvement fellings on a cycle of 20 years.

Exploitable sizes.—*Sal* 6 feet 4 inches girth, varying sizes for other species.

Rotation.—160 years for *Sal*. 80 years for other species.

Yield.—Annually 1/20th of the productive area in each Felling Series.

Felling rules.—Fellings to be made on silvicultural grounds only and to follow the sequence given.

Dead and fallen trees may be removed at the discretion of the Divisional Forest Officer.

Subsidiary regulations.—Climber-cutting and freeing of young regeneration will be done on a 10-year cycle according to the programme laid down.

III.—THE TEA GARDEN LONG ROTATION WORKING CIRCLE

Silvicultural system.—Conversion-to-Uniform by clear-fellings followed by regeneration by *taungya*.

Exploitable size.—6 feet 6 inches girth over bark.

Rotation.—60 years.

Yield.—By area. Theoretically 1/60th of the productive area. In actual practice it will be somewhat less as large areas have already been regenerated artificially on a much shorter rotation under the previous Plan. The yield is, therefore—

$$\frac{\text{area available for felling, } viz., \text{ coppice and old forests}}{\text{rotation—age of the oldest plantation.}}$$

Felling rules.—Fellings will follow a definite sequence, the annual coupe in each Felling Series will be one compact block, a compartment should be fully worked over before the next is taken up.

Subsidiary regulations.—Extraction must be completed by the 15th March so as to allow slash to be thoroughly dry for a good fire. The species chosen for restocking are *gokul* (*Ailanthus grandis*), *panisaj* (*Terminalia myriocarpa*), *chickrassi* (*Chukrasia tabularis*), *toon* (*Cedrela toona* and *microcarpa*), *angare* (*Phoebe hainesiana*), *kimbu* (*Morus laevigata*), *labshi* (*Polyalthia simiarum*). Experiments are to be made with *gokuldhup* (*Canarium sikkimense*), *tarsing* (*Beilschmiedia sikkimensis*) *khanakpa* (*Evodia meliaefolia*), *chhatiwan* (*Alstonia scholaris*). Climber-cutting will be done (except in the Minglas Felling Series) on a 5-year cycle at the rate of 1/5th of the productive area in the sequence given. The existing stock in the Mingals Felling Series is a mass of creepers. Here, in addition to the annual clear-felling coupe which is to be converted by *taungya*, another coupe 20 years in advance of the former will be clear-felled, burnt and sown broadcast with seeds of fast-growing fuel species,

IV.—THE TEA GARDEN SHORT ROTATION WORKING CIRCLE

Silvicultural system.—In certain areas the system is coppice-felling supplemented with broadcast sowing of seeds of fast-growing fuel species elsewhere clear-fellings followed by *taungya* regeneration of fuel species.

Rotation.—20 years, at which age many of the fast-growing species start dying out.

Yield.—By area. Theoretically 1/20th of the productive area. In actual practice it will be somewhat less owing to the existence of a large acreage of plantations of long rotation species which has been excluded from the area available for felling.

Felling rules.—Fellings to follow a definite sequence and the annual coupe in each Felling Series to be a compact block.

Subsidiary regulations.—Species chosen for broadcasting with coppice and for *taungya* are local fast-growing fuel species, *jarul* (*Lagerstroemia flos-reginae*) for damp areas. Climber-cutting in coppice will be done for the first three consecutive years and thereafter every fifth year. A heavy thinning, both in coppice and *taungya*, will be done in the fifth year. Existing long rotation plantations in this Working Circle will be felled when they reach merchantable size or earlier if they show poor growth and such areas will be added to that required for growing fuel. Advance felling should be carried out if certain species start dying out in areas not due for felling and the ordinary sequence of fellings will be suspended.

V.—THE PANKASARI WORKING CIRCLE

Silvicultural system.—Conversion-to-Uniform by clear-fellings followed by regeneration by *taungya*. It is proposed to raise a 2-storeyed forest, the upper storey to consist of fast-growing light demanders suitable for box-planking and veneer and the lower storey to consist of slow-growing shade-bearers yielding hard wood for various purposes. The upper storey will reach the exploitable size much earlier and will be removed in one of the thinnings.

Exploitable size.—6 feet 6 inches girth over bark.

Rotation.—100 years with 10 periods of 10 years each.

Periodic Blocks.—Only Periodic Block I has been allotted and contains 1/10th of the total cultivable area in the Working Circle. Periodic Blocks II to X remain unallotted and contain areas already regenerated and old forests not included in Periodic Block I.

Yield.—In Periodic Block I one-tenth of the cultivable area will be clear-felled. In Periodic Blocks II to X selection fellings combined with improvement fellings will be done on 1/20th of the cultivable old forests.

Felling rules.—Periodic Block I.—Fellings will follow the sequence given, small precipices included in the annual coupe should be left unfelled, but should count against the yield of the year.

Periodic Blocks II to X.—Selection fellings to follow the sequence given and marking to be done on silvicultural grounds only. Dead and fallen trees may be removed at the discretion of the Divisional Forest Officer.

Subsidiary regulations.—Choice of species.—Utis (*Alnus nepalensis*), *saur* (*Betula alnoides* and *cylindrostachys*), *malata* (*Macaranga pustulata*) as over-wood. *Panisaj* (*Terminalia myriocarpa*), *phusre champ* (*Michelia lanuginosa*), walnut, *pipli* (*Bucklandia populnea*), *kapasi* (*Acer campbellii*), oak (*Quercus lineata*), *lapche kawla* (*Machilus edulis*), *lali kawla* (*Machilus gammieana*) as under-wood. Experiments are to be carried out with *khanakpa* (*Evodia fraxinifolia*), *bhadrase* (*Eleocarpus* (*lanceaefolius*), and *mahwa* (*Engelhardtia spicata*).

Climber-cutting is not ordinarily necessary, if required, may be done with selection marking.

Special treatment for the Iche Felling Series.—Some compartments are almost bare of tree growth. These are to be cleared and planted up with fast-growing species so as to prevent a drop in yield when these areas are taken up for conversion.

VI.—The Protection and Inaccessible Working Circle

Method of treatment.—Generally no fellings are prescribed but, occasional trees may be removed by selection. Areas which become accessible by extension of communications, etc., may be transferred to other Working Circles and formed into separate Felling Series. Dead and fallen trees may be removed at any time.

Miscellaneous Regulations

Taungya Works.—Clear-felled coupes to be restocked by *taungya* by forest village labour.

Climber-cutting in plantations.—As and when required. Divisional Forest Officer responsible. Several cuttings during the first few years.

Thinning in plantations.—In the fifth cold weather after formation and thereafter every fifth year. *Lampate* (*Duabanga sonneratioides*) may be thinned in the 3rd year, if necessary. A Divisional Thinning Register is to be maintained.

Survey of plantations to be done in the first cold weather after formation, all species or mixtures to be surveyed separately.

Inspection paths and name-boards in plantations.—Diagonal paths in all plantations and perimeter-paths as long as fence is in place. Name-boards to be fixed as directed.

Extraction of tama bamboos (*Dendrocalamus hamiltonii*).—Only mature bamboos may be felled, cutting should be done flush with the rhizomes and tops pulled down.

Removal of dry sticks.—On permit.

Removal of minor produce.—On permit or monopoly sale by sealed tender.

Fire protection.—Leaf fires in *Sal* forests at the discretion of the Divisional Forest Officer. Grass and bamboo areas and new formations in river beds must be strictly protected. Existing fire lines to be maintained.

Grazing.—Open grazing restricted to the Protection and Inaccessible Working Circle, stall-feeding allowed elsewhere.

Boundary cleaning.—Artificial boundaries to be cleaned annually, special checking to be done on a 4-year cycle according to the programme laid down.

Maintenance of Preservation Plot No. 1, Bengal.—Species preserved—*Nageswari* (*Mesua ferrea*). To be preserved in its natural state. Climber-cutting is the only operation permitted.

SEEDLING REGENERATION IN B—3 SAL

By E. A. Smythies, I.F.S.

At the outset of this article, to avoid any possible misunderstanding, I should like to emphasise that it applies almost exclusively to good quality Bhabar Sal forests (Champion's B—3 type) west of the Sarda river, and deals with the results of research and experiments carried out prior to June 1932, which have now given results that may with confidence be applied in Working Plans to such areas.

1. To make matters still clearer I should perhaps add that the conclusions arrived at in this note do *not* apply to—

(*i*) areas subject to frost (*e.g.* Dehra Dun);

(*ii*) areas subject to drought and regression to a more xerophytic type of vegetation (*e.g.* Jaspur, Horai, Champion's A—2 type);

(*iii*) Tarai and Plains forests (Champion's B—4, 5, 6 types);

(*iv*) dry hill forests (Champion's A—1 and B—1 types).

It also seems advisable to try and define what exactly I mean by whippy *sal* regeneration, as opposed to woody and carroty.

By *woody*, I mean growth at least as thick as a man's thumb, which resists bending, and with definite bark beginning to be rough.

By *carroty*, I mean growth between the thickness of a man's thumb down to his little finger, without definite rough bark, but with a somewhat juicy or carroty appearance.

By *whippy*, I mean growth about as thick (near the base) as a pencil or cigarette as a maximum down to a No. 6 or 8 knitting needle, which gives no resistance to bending, and has thin perfectly smooth bark.

By *unestablished seedling* I mean anything thinner than a No. 8 knitting needle $\frac{and}{or}$ less than 24″ high.

To a certain extent, in order to bring out a logical sequence of argument and idea, I have in this note repeated information already recorded in Champion's excellent summary of our knowledge of *sal* regeneration as it was at the end of 1932. But one or two important points, which were in doubt in 1932, and which have now been clearly established, are discussed in paras. 7 to 11 of this note. It is perhaps superfluous to add that they confirm Champion's tentative conclusions.

Before dealing with the experimental period, however, I will go back a stage further and remind my readers of an important point in natural *sal* regeneration, which was obvious before any research work started. It is a well-established fact that, *without exception*, our finest and best stocked almost pure *sal* forests of the present-day developed naturally from a state of utter ruin 70 years ago. The following extract from Sen's Ramnagar working plan is typical of the whole tract—

"All good trees in accessible places were ruthlessly cut, and were it not that nature has given to *sal* great reproductive power the Forest Department would have subsequently found little forest to conserve. About the middle of the 19th century the demands of the railways for sleepers induced many speculators to enter into sleeper contracts and these men were allowed to cut down trees far in excess of what they could export. To such an extent was this reckless felling carried on during this period, that for several years after the forests were properly taken in hand the energies of the forest officials were directed towards extracting the timber left behind in the forests by contractors. Forest management in fact received no attention previous to the Mutiny. Contractors did as they pleased and cut every marketable stem in the more accessible forests. The restoration of the forests dates from 1861, when Major Ramsay, Commissioner of Kumaun, wrote that all the accessible forests had been overfelled and that these exhausted areas must be given a rest ; the chief object of management must be to restore the forests to a prosperous condition and that with

this end in view, an efficient establishment was required for their protection. In 1861, Major Ramsay was appointed Conservator of Forests in addition to his other duties. He quickly abolished farming of leases and started systematic management. He stopped indiscriminate fellings and arranged for the marking of trees. In 1863, the forests of Kumaun were first placed under the control of officers of the Forest Department, Major Pearson being the first Conservator. In 1871, this officer wrote as follows: "Thanks to the care and administrative ability displayed by Colonel Ramsay, the demarcation of the great *sal* forests of Kumaun and Garhwal was completed some years ago in a very perfect manner. The result has been most favourable *and the forests are now everywhere recruiting themselves*."

2. We have, I believe, a picture of our forests of 1860 in the Nepal forests of the present day, where all accessible areas are felled heavily, and all the forests burnt annually and grazed by cattle perpetually. If there was a Colonel Ramsay now in Nepal, a million acres of *sal* forest would respond immediately and in 70 years produce the well-stocked even-aged *sal* crops that we have now, as a million acres of Nepal have *sal* regeneration beyond our dreams.

I might also mention the Gorakhpur Division, the bulk of which, and particularly the most valuable and best stocked *sal* areas, consist of tracts where the land grantees of the mid-19th century *failed, despite their most strenuous efforts, to destroy the sal forests*, and this failure enabled Government to regain the lands. Champion has recorded it as a definitely established fact that seventy years ago, a semi-ruined good quality *sal* forest usually responded immediately to protection, and regeneration grew up profusely: "Forest management has by protecting the forests from unregulated felling, burning and grazing, allowed the progression to start again. In particular, it has permitted the establishment and growth of enormous quantities of *sal* regeneration held in check by fire and is very largely responsible for the present-day appearances." Has anything happened in the last 70 years to alter this ? Let me give some more recent examples which help us to answer this question.

3. Twenty-seven years ago, when I was a youngster of under one month's service, I was one day on an elephant with Sir Peter Clutterbuck (my D. F. O.), passing through an extensive area of dense *sal* sapling and young pole crops, with scattered overwood, and Sir Peter said, "And these are the compartments that Eardley Wilmot was cursed for having destroyed!"

There are at the present time two fairly extensive areas in the province of about 700 acres each, where the natural *sal* seedling regeneration has come up so abundantly that the revised working plans have prescribed with confidence their complete freeing and final felling of overwood within the Working Plan period. One area is in Bahraich (Bhinga block) and one in Ramnagar (Kota Dun). Both areas have much the same past history, *i.e.*, an open *sal* forest *intensely* overgrazed by village cattle, and then suddenly closed to grazing about 15 years ago. Intense over-grazing is a recognised form of forest destruction; is it a mere fluke and coincidence that the two worst grazed areas in the province 15 years ago should now be the two best regenerated? (I do not, however, advocate intense over-grazing as a sure method of *sal* regeneration!) To quote another recent example, the *sal* forests of parts of the Tarai and Bhabar Estates have always been open to unlimited grazing, and have usually been burnt. The seedling regeneration here in open patches, not liable to water-logging, reminds one of the regeneration in Nepal. Wonderful *sal* seedling regeneration is also found in the Bijorgad block of Kalagarh Division, which is continually and heavily grazed by village cattle. Here are some comparatively modern examples of brutal treatment producing excellent *sal* regeneration in good quality areas *which had never been tenderly treated*. This gives us grounds for answering the question in para. 2 above—what was true 70 years ago is true to-day, provided that past treatment, climatic conditions, or other factors have not fundamentally altered the œcological conditions.

4. It has, however, long been recognised that œcological conditions have been fundamentally and extensively altered, and this proviso is the basis of all our troubles. In the first place, the rush of regeneration 70 years ago, following protection of ruined areas,

produced a phenomenon altogether new, *i.e.*, densely stocked even-aged *sal* crops over large areas, the like of which probably never existed before. Under the dense shade of these *sal* crops, continued protection from fire and grazing, in course of time, killed out grass and brought in a mass of shade-bearing evergreen weeds, typically Clerodendron and Mallotus producing œcological conditions for *sal* seedlings utterly different to the open grassy semi-ruined conditions from which our forests arose, and it was a matter of common knowledge that *sal* would not regenerate itself under these conditions.

At this stage, Hole began his long series of detailed experiments and observations on *sal* œcology. He proved conclusively that such conditions were absolutely inimical to *sal* seedlings, particularly the heavy shade, the raw humus, the acidity, the weed competition. His publications of 15 years ago threw a flood of light on *sal* seedling œcology. He then applied the results of these studies to actual regeneration in the field. His experimental strip fellings were carried out in Dehra Dun, and his publications of 1919 and 1921 gave a detailed account of his results. By 1920 he had definitely raised natural *sal* seedling crops in his strips, and must therefore have solved the problem. The strip fellings ensured adequate clear overhead light and helpful side protection. His experimental plots were strongly fenced and given rains weeding, but the importance of these aids was not clearly understood in the Provinces, so that when in 1920 and 1921 strip fellings were carried out in Haldwani, South Kheri, and elsewhere, in which neither fencing nor weeding was done, they failed completely. It has taken another 12 years and a further long series of experiments to discover that not one but three vital factors were concerned in the regeneration of our dense weed and deer-infested *sal* forests.

5. In 1920 when I was Silviculturist in the United Provinces, Mr. Trevor (then Conservator, Working Plans Circle), asked me to start a new series of experiments in Haldwani Division. Accordingly (H. G.) Champion and I started 25-acre experimental plots in 1921, covering the following variations of overwood—

(*i*) Clear-felling ;

Photo No. 1.—Majhola, Haldwani Division.—10 years after felling and burning. The large stem in the centre of the picture is woody coppice and now 7½″ diameter and rough bark. The remaining stems in the picture now 3″—4″ diameter and smooth bark are from whippy shoots.

Photo No. 4.—Sela 5—Haldwani Division.—P. B. I. continuously treated with dense overwood, fire protection, no deer fence. Result—dense evergreen invasion and no *sal* regeneration.

(*ii*) Shelterwood felling, leaving only 12 standards per acre ;

(*iii*) Strip felling ;

(*iv*) Dense shelterwood (about 50 to 60 standards per acre).

By 1926, plots (*i*), (*ii*) and (*iii*) had all failed, but had given the following valuable information—

(*i*) That small whippy *sal* regeneration will respond vigorously to ample light ;

(*ii*) That these shoots will be heavily browsed by deer, chiefly *sambhar* ;

(*iii*) That with this check they will be completely swamped by weeds ;

(*iv*) That a heavy felling and fierce burn of refuse will produce vast quantities of *haldu* (*Adina cordifolia*) regeneration, which is also doomed, like the *sal*, to disappear if left unprotected from deer and weeds.

6. In March 1926 I started, and Mr. Brahamawar completed, a small but most instructive experiment at Majhola in Haldwani division. In a large miscellaneous forest on the borders of the Tarai, *heavily grazed and annually burnt*, a few large *sal* trees had produced masses of whippy regeneration mostly about 3′ high, with a few woody shoots and one small group of young poles, all very similar to vast areas in Nepal. The overwood was almost clear-felled, the area burnt, had one rains weeding and then left to fend for itself but fire-protected for 8 years. After 10 years, the results obtained are very interesting. Many of the whippy shoots failed to get away, and still persist as 3′ to 4′ whippy shoots ! But many whippy shoots succeeded in getting away *and now form groups of 4″ diameter poles 30′ to 35′ high.*— Photograph No. 1 shows one of these groups and the development shown in 10 years is remarkable.

7. In 1927, Howard erected in Haldwani division the first deer-proof fence in the Province around a so-called failed plantation of teak. The astonishing development of a few miserable little *sal* seedlings was immediately observed, and Chaturvedi in 1929 laid out two detailed observation plots, which also gave very instructive

results. Although damaged once by *sambhar* that broke in, the recorded measurements in 7 growing seasons have shown an *average* development of a number of seedlings from 16″ to over 10′ high, while one seedling 43″ in 1929 (after one year of fence) is over 20′ high in 1935.

In 1928, I suggested the erection of a second deer-fence around a compartment (Sela 3) with good groups of *sal* whippy shoots about 3′ high in the more open areas, and this was erected by Howard in May 1928. The results were so promising that in 1929 I obtained Chief Conservator of Forests sanction to the erection of 7 more 100-acre deer-fences (4 in Haldwani, 3 in the Eastern Circle), in areas of good whippy regeneration. In a note which I wrote over six years ago (October 1929) I said : "A deer fence is obviously a device only for areas of concentrated regeneration liable to severe damage by deer, and more especially a device to enable us to carry out heavy fellings of the overwood, where without it we probably could not make such fellings. To leave for an indefinite period a heavy canopy inside a fence nullifies the object of the fence, as the regeneration will remain suppressed and not receive the stimulus of ample light that it requires for its further development." In December 1930, I obtained sanction to carry out heavy fellings over existing whippy shoots inside some of these fences, and Stewart (D. F. O., Haldwani), made two experimental plots of 10 acres each (*i*) one of clear-felling, and (*ii*) one with a light shelterwood of 12 *sal* standards per acre. These were repetitions of the 1921 experiments *but with the addition of a deer-proof fence.* By 1932, both heavily felled areas had developed very vigorous weed growth, and shrub cutting to assist the *sal* regeneration was carried out and has been continued since. By a somewhat laborious system of trial and error we had thus reproduced the three vital conditions with which Hole had succeeded a dozen years before, *i.e.*, (*A*) Ample overhead light ; (*B*) Protection from deer where necessary ; (*C*) Protection from excessive weed competition. The results are shown in Photograph No. 2, plot (*i*), Sela 3, the same spot as photographed by Champion in January 1933 (compare plate 11, page 41 of his book). In December 1930, the seedling growth in plot

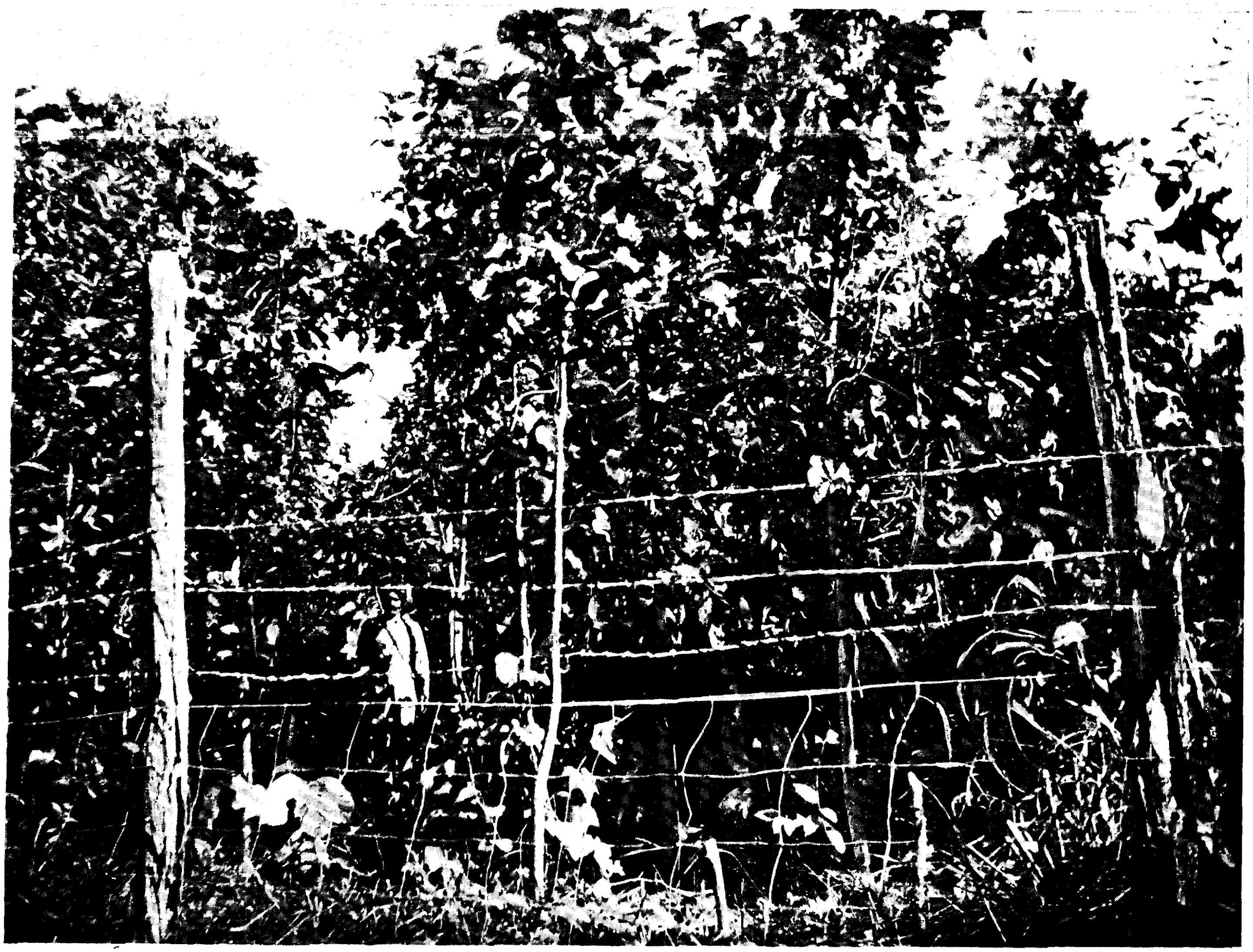


Photo No. 2.—Sela 3—Haldwani Division.
Sal saplings from whippy growth 5 years after clear felling.
(Compare the same view 3 years earlier in Champion's Plate 11, page 41.)

Photo No. 3.—Sela 5—Haldwani Division.
Sal saplings from whippy growth (left centre of picture) with overwood of *sal* removed

(*ii*) was recorded by Stewart as 1′ to 2′ height. It is now 7′ to 15′ after five growing seasons.

Equally good results have been obtained in an adjoining fenced area (Sela 5), wherever the canopy was open or heavily felled. Photograph No. 3 shows the corner of this fence, with overwood mostly removed and *sal* saplings (in the centre) up to 15′ high. On the right background is P. B. I area outside the fence.

Photograph No. 4 shows the P. B. I area immediately outside the fence, adjoining photograph No. 3. Notice the density of the overwood and the solid evergreen invasion. The *sal* whippy growth that was abundant 8 years ago has almost entirely disappeared.

All the Haldwani deer-fenced areas of 1928 and 1930 (5 in all) *prove conclusively* that factors (*B*) and (*C*) without (*A*) will *not* produce sapling crops quickly, similarly (*A*) and (*B*) without (*C*) or (*A*) and (*C*) without (*B*) will usually fail. But with all three factors favourable, up to now WE HAVE IN EVERY CASE SUCCEEDED (in Haldwani division) in producing healthy young *sal* sapling *crops* from whippy shoots in 5 to 7 years after heavy felling. Supporting evidence is available in the Eastern Circle (*i*) Pilibhit division (*B* without *A* and *C*, a failure); (*ii*) North Kheri division (*A* and *B* and *C*, a complete success). Champion has noted (page 115) that a similar discovery, *i.e.*, that heavy or clear felling over whippy shoots produced excellent sapling growth, was made by Minchin so long ago as 1916 in Ganjam. Minchin made this discovery after a visit to Gorakhpur where, in the Northern forests particularly, a fair proportion of the future crop is obtained in the regeneration areas by clear-felling over whippy and small woody shoots (as well as coppice). In Singhbhum, Champion (page 102) writes: " where enough (whippy) regeneration was already on the ground, clear-felling has been done with excellent results." Similarly in the Central Province (page 123), and there is every indication that what is true in Ganjam, Singhbhum, the Central Province, and Gorakhpur, is equally true in Haldwani or anywhere else where adequate whippy regeneration already occurs provided due attention is paid to the three vital factors—*A*—Canopy, *B*—deer browsing, *C*—Weeds. But the experiments carried out between

1920 and 1932 did not succeed in establishing natural seedlings *de novo*. If or when this problem is solved, the credit will be due entirely to more recent research work.

8. The success achieved to date with existing regeneration suggests that there are no other vital factors to be considered for whippy growth. This conclusion is supported by a careful comparison of the differences in management between the Nepal forests and ours, and the resulting differences in growth conditions. The comparison is made clear from the following tabular statement—

FUNDAMENTAL DIFFERENCES IN MANAGEMENT BETWEEN		Causing marked differences of	Vital factors affecting *sal* seedling regeneration (*vide* para. 7).
Nepal.	U. P.		
A Unregulated fellings	Cautious regulated fellings	Canopy	A—Canopy
B No game protection, and few deer	Game protection and many deer	Deer incidence	B—Deer browsing
C No fire-protection	Fire-protection	Weeds (and canopy)	C—Weeds
D Uncontrolled grazing of village cattle	Little or no cattle grazing	Weeds	

I can think of no other fundamental differences in management (*e.g.*, cultural operations and creeper cutting) that can bear on the argument. The question naturally arises, if Nepal could produce our wonderful well-stocked *sal* forests if they adopted our management (every one admits this), could we in time produce the wonderful *sal* regeneration of Nepal with some nearer approach to their management (or lack of it) ?

9. So far as existing whippy seedling growth is concerned, the period of research and experiment—or if one prefers, of trial and error—that started with Hole's researches a quarter of a century ago, is over. The fact, and it is a fact, that wherever the three vital factors have received adequate attention, successful sapling crops have been created in a short time from existing whippy seedlings is our justification for applying these results to working plan conditions. That our successful examples are not on a far larger scale is due to

our conservative outlook. In June 1932, at a conference in Naini Tal, I urged as strongly as I could that *B* without *A* was very little use, *i.e.*, that our deer-fences would not function or prove their real worth unless we made fairly heavy fellings inside them *over existing regeneration*. In a note for this conference I pointed out that deer and weeds were two important factors, and that, " ample overhead light and particularly freedom from overwood of *sal* itself is at least equally important." I added, " I am convinced we must fell these deer-proof fences more heavily than at present to get adequate results. When there was a good deal of scepticism on the subject of deer damage I was ready to risk my reputation on the advantages that would result from protection from deer, and on the evidence available I am quite prepared to risk it again now on the subject of heavier felling." I also pointed out the risk we were running in other P.B.I areas in losing our whippy regeneration " with an overhead canopy and evergreen undergrowth that every season grow heavier and denser." (See photograph 4.) I hope these quotations from a four-year old note will establish my claim that I knew then what would happen and what we should do. However, I failed to convince the conservative elements on the conference, who, however, had no objection if I took the responsibility of making the heavy fellings. So I took over 200 acres of existing deer-fences stocked with abundant whippy *sal* seedlings as U. P. Silviculturist's experimental areas. Photograph No. 3 (*not* a Silviculturist's area) illustrates the technique I advocated in 1932, *i.e.*, a light overhead canopy, shrub-cutting, and a deer-fence. Result—*sal* regeneration is developing excellently. As the U. P. Silviculturist in due course will write a complete note, I will say nothing here about them except to add that they now form his show experiments in the province, to which all forest officers, from the Inspector-General and Chief Conservators downwards, are proudly taken. They provide a complete vindication of my statements and attitude at the 1932 conference, and a vivid contrast with the weed-infested, fire-protected, heavy-canopied areas that have resulted from the very conservative treatment in many P. B. I compartments of this Division. To illustrate the conservative nature of these

P. B. I fellings, I may mention that some of these areas have recently been re-enumerated and the Working Plan Officer informs me that they show a larger growing stock of *sal* (in volume units) over 12″ diameter than they had 10 years ago! The fellings have not even equalled the increment! By way of contrast with photograph No. 3, photograph No. 4 shows the conservative method of *sal* regeneration, *i.e.*, dense canopy, dense evergreen shrubs, no fence. Result—*sal* regeneration completely stagnant or retrogressing. It will, I believe, take several years of burning following some felling to bring these latter back to the stage of grass and whippy *sal* as I remember them when I was Divisional Forest Officer 10 years ago.

10. I will cite the following examples of application of heavy felling over whippy regeneration in current working plans—

(*i*) In my preliminary working plan report for Bahraich, I proposed clear-felling and shrub-cutting and if necessary deer-protection in the Bhinga area (*vide* para. 3 above). This has been adopted, and 50 acres per annum will be taken in hand for the next 15 years.

(*ii*) In the Kota Dun area of the Ramnagar division (para. 3 above), the Working Plan prescribes complete *natural* regeneration in the next 15 years of nearly 700 acres.

(*iii*) In the Tarai and Bhabar Working Plan, clear-felling and *artificial* regeneration of *sal* is prescribed in one Working Circle. Stewart (the D. F. O.), who 5 years ago was instrumental in creating some of our most convincing experimental plots in Haldwani, and who is in complete agreement with the conclusions of this article, has found in some of his coupes plenty of whippy *sal* seedlings already on the ground. He is taking these as his future crop, and clear-felling over them without hesitation, thereby—in my opinion—definitely improving on the working plan prescriptions. The Divisional Forest Officer, Haldwani division (Bhola), has adopted the same practice wherever groups of *sal* seedlings occur in his artificial regeneration areas.

(*iv*) In the second Working Plan report for the revised Haldwani Working Plan, Raynor (Working Plan Officer) has written alternative chapters for two Working Circles in the Bhabar *sal* areas, the second

alternative to be adopted "when the problem of natural *sal* regeneration has been solved." For all or any areas in these two Working Circles, where *sal* whippy shoots already exist in adequate numbers, I maintain without qualification or hesitation that the problem is already solved. In fact, as territorial Conservator, I am prepared to guarantee success in such areas at comparatively low cost, whereas I am not prepared at present to guarantee success with artificial regeneration even at a cost of Rs. 100 per acre. Both the present and the previous D. F. O.'s (Messrs. Bhola and Stewart) agree with me.

11. Champion in 1933 (page 42) wrote—"Some areas with adequate established seedling and small pole stocks on the ground can be regenerated without difficulty by clear felling." Subsequent developments have proved that the same applies to areas with adequate whippy seedlings 2′ to 3′ high, provided we protect them for a few years from deer and weeds. As a point of practical Forestry, the importance of this advance in any particular forest depends on the extent of such areas. While these are being dealt with, we shall have further time to tackle the last stage in the problem, *i.e.*, how to obtain adequate whippy growth *de novo* in our mature well-stocked good quality *sal* forests invaded with evergreen weeds. The U. P. Silviculturist has started experiments in Ramnagar and Haldwani divisions and elsewhere, and will presumably in due course publish an account thereon. Personally, while I believe the problem is approaching solution, I would not be prepared to *guarantee* success within a reasonable time at the present moment.

Champion in 1933 made the following suggestion—"Controlled burning as a measure to eliminate undergrowth of Mallotus, etc., and get adequate unestablished regeneration prior to regeneration fellings requires further study, continuing the burning for a longer period and watching the effect on recruitment for which precise data are desirable. It has to be determined how far this can be carried as a P. B. II operation." The 25 acre plot started by Champion and myself 15 years ago (plot *iv*, dense shelterwood, *vide* para. 3 above) throws some light on this. Although burnt continuously for 12 years,

it never produced an adequate crop of 2′ high seedlings under a complete canopy. The U. P. Silviculturist has now taken it in hand and is experimenting with different grades of canopy.

Personally, I am doubtful if an adequate seedling crop of *sal* can be induced under P. B. II conditions, *i.e.*, with a complete *sal* canopy. But if it can, I believe it can be induced *quicker* with a somewhat more open canopy. It is a curious but well-established fact that whereas vigorous grass in an artificial plantation is an indication of probable failure, the appearance of mild grass in a natural (shelterwood) regeneration area is the first indication of possible success. Hence, the canopy has to be opened to enable grass (assisted by burning if necessary), to begin to come in adequately but not too vigorously. Many years of annual burning in an evergreen infested North Kheri experiment failed to bring in grass under a full canopy. Clear felling and burning in a damp Tarai area in the Tarai and Bhabar Estates (Champion's B—6 type) induced abundant and vigorous grass in three years. Ford Robertson has recently noted a great increase of grass, following fairly heavy felling and burning, in an area he marked himself 3½ years previously. In some of the P. B. I areas of Haldwani division, between 1920 and 1935, the change from grass to evergreen, then again to grass following shelterwood fellings and burning, then once more to dense evergreen following gradual closing up of the canopy and fire-protection, has been most noticeable. Champion notes a number of cases where felling and burning has converted evergreen undergrowth into grass in areas much moister than our Bhabar *sal*, *e.g.*, Eastern Tarai (Assam) and coastal *sal* (Puri, *vide* plate 19 of Champion's book). The available evidence does definitely indicate that with mild felling and burning we can *still* get back to grass almost anywhere in this type of forest within quite a short time. Having done so, can we guarantee that adequate *sal* whippy regeneration 2′ to 3′ high will come up within a relatively short period ? That is the *final* question we are waiting for the Research Branch to answer. If they can prove this, in my opinion *the whole sal regeneration problem of the Bhabar sal will have been solved and we shall be able to guarantee successful regeneration* de novo *within*

a reasonable P. B. I period, when and where we wish. The regeneration sequence would then be somewhat as follows—

(*i*) Convert a weed-infested, fully-stocked mature *sal* crop into a somewhat more open crop with grass. Time, say five years.

(*ii*) *Adequate* whippy *sal* recruitment to develop in the grass to about 2′ high. Time unknown; say x years. (This is the crux of the problem.)

(*iii*) Convert the 2′ growth to 10′ saplings by *heavy* fellings, fire-protection, shrub-cutting and where necessary a deer-fence. Time 5 to 7 years.

(*iv*) Final felling and removal of fence.

Total period$=12+x$ years from first felling.

Stage (*i*)—and possibly (*ii*)—is a tricky period of management, with moderate or light felling, burning, possibly grazing, etc., while stage (*iii*) is an easier period of management, with protection from fire, animals and weeds. But since it is unlikely that natural regeneration can be depended on to regenerate whole compartments without occasional gaps or failures, I believe the final technique that will evolve will be to induce and utilise as much natural growth as we can, and the gaps and failures will be filled up artificially. And this, when one comes to think of it, is getting back fairly closely to European Forestry! It is the technique evolved *and already applied* (on a small scale) by Stewart in the Tarai and Bhabar Working Plan.

12. Stages (*i*) and (*iii*) may be regarded as definitely proved, while stage (*ii*) is under examination, and I believe will be definitely proved within the next Working Plan period (15 years). Whenever in a Conversion working circle a Working Plan Officer can indicate sufficient mature areas, with adequate whippy seedlings already present to form a 15 year P. B. I area, I would urge that a conversion or *Quartier bleu* system of management should be continued, but with a conservative Q. B. period. At any rate, if I was the territorial Conservator, I would be quite prepared to take the responsibility of guaranteeing the success of such areas within a Working Plan period. Without stage (*iii*) already present, however, I do not see how we

can yet adopt conversion on a Working Plan basis, at least until we have some idea about x. Champion, in 1933, commenting on management of B—3 forests in the United Provinces, wrote : "The consequence has been a reversion (temporary it is hoped) to selection fellings wherever regeneration cannot be guaranteed." I think this temporary reversion was justified until the stage (*iii*) had been proved. But now that we can guarantee success with stage (*iii*) conditions present, I can see no justification for not continuing conversion, to the extent that stage (*iii*) areas permit.

13. The vigorous development of evergreen undergrowth in all successfully fire-protected well-stocked areas is a definitely established fact. Admitting we can *still* get back to grass fairly quickly by burning, etc., the question arises, shall we always be able to do so, or will a stage arise, as it has in Bengal, when we shall find it impossible to burn the forest ? Further, will a stage arise, again as it has in Bengal, where the soggy undergrowth forms definitely unhealthy conditions for the *sal* overwood, which is liable to be badly affected by root fungus ? I think that Working Plans should prescribe occasional controlled burning—say in big seed years (about one in three)—to keep the evergreen in check and the forests healthy. The idea that burning results in widespread drought damage, although held by some forest officers, is, I believe, a fallacy. At any rate, I do not believe an occasional burn will do any harm. Champion notes that in the analogous forests of the Central Provinces (B—2 b : page 122) and Singhbhum (page 102), general fire-protection has been abandoned.

14. In para. 8 above I indicated that one of the predominant differences in management between Nepal and our forests was cattle grazing. This is a factor which, I think, deserves much more attention and certainly more research than it has hitherto received. When I was drafting the tabular statement in para. 8, I brought in cattle grazing, as it was an obvious difference in management, but without any very clear idea how it could affect the regeneration problem. Thinking it over, it struck me that it might be quite an important factor. Recalling the areas of best *sal* seedling regeneration known

to me, Nepal, Bhinga, the Kota Dun, Bijorgad Block of Kalagarh, Tarai and Bhabar areas, Sela,—uncontrolled grazing was, or had fairly recently been, a common factor to all of them. This is beyond the bounds of coincidence. Conversely, many areas which for years had been most strictly protected from grazing, such as Lakhmanmandi, were deficient in seedling regeneration. Is it conceivable that cattle grazing, instead of being a confounded nuisance that foresters unwillingly tolerate and eliminate as far as they can, is in fact a *useful factor* in the production of gregarious sal crops ? To be more explicit, does it influence the missing factor that we are searching for in the stage (*i*), and early stage (*ii*) of the natural regeneration sequence, and is it therefore an important factor in that unknown x of para. 11 of this note ? Let me put it another way. In natural regeneration we have proved that shrubs and woody weeds may be an important factor in stage (*iii*). In artificial regeneration we know that grass and herbaceous weeds are a vital factor in what corresponds to stage (*ii*), *i.e.*, getting the plantation seedlings to 3′ high. It seems therefore a plausible deduction that grass and herbaceous weeds are an equally important factor in stage (*ii*) of natural regeneration. If so, the elimination or reduction of weeds should materially reduce our unknown x. One way of reducing weeds is by cattle grazing, rather a rough way admittedly and possibly not the best way, but still a way. Is it possible by grazing to prevent weeds occupying the ground before sal regeneration starts, or to keep weed competition in check during the crucial years that the young sal seedlings take to establish themselves ? Nothing but experiment will answer these questions. Two or three years ago Mobbs (U. P. Silviculturist) suggested jokingly, but with a flash of inspiration—that the Research Branch should keep a herd of cattle to test the grazing factor.

However, in the hope that the Research Branch may in time be free to take them over, I have asked Divisional Forest Officers to start one or two divisional experiments in stage (*i*) weed-infested areas where we have failed completely to induce regeneration to date. It is a curious reversion of our usual practice to employ a cattle guard to drive village cattle *into* our forests instead of out of them !

15. To summarise the chief points of this article—Our well stocked evenaged *sal* crops are a new phenomenon in *sal* history, created by protection 60 or 70 years ago. Under them the œcological conditions are very different to the conditions when they started, and inimical to *sal* seedlings. The first stage in regenerating a weed infested fully stocked crop is to thin out and burn, which will bring back mild grassy conditions in a few years. The second stage is to induce abundant *sal* recruitment to come up in the grass. How long this will take is not yet known. Possibly cattle grazing is a factor of importance at the beginning of this stage. When this recruitment reaches the whippy state about 2′ to 3′ high, the third stage is to carry out heavy fellings, and protect from fire, deer and competing weeds, when the whippy growth will develop into 10′ sapling crops in 5 to 7 years, and be ready for a final felling. Wherever *sufficient* areas in a Working Circle are ready for the third stage, it can be applied on a working plan scale without hesitation, and such areas can and should form the P. B. I. of a conversion working circle.

These conclusions are fully supported by experiments in the United Provinces laid out up to June 1932, and also fully supported by results obtained in similar forest types in other Provinces. They are in general conformity with Champion's "Regeneration and Management of Sal," 1933.

In conclusion, I must acknowledge with thanks considerable assistance in the final drafting of this article from most useful comments by Champion on the original (and now amended) draft.

[In this connection it will be interesting to see the remarks of the I. G. Forests in his recent inspection note on Assam, suitable extracts from which are printed below.—*Ed.*]

Kamrup Division

* * * * * *

Briefly regeneration is to be obtained by burning the ground cover to eliminate evergreen and encourage thatch grass, by opening the canopy in clear felled groups or strips starting from foci

where advance growth is already present and at a subsequent date by protecting the regeneration from fire.

*   *   *   *   *   *

The original large groups and especially the strips have failed chiefly due, I think, to the heavy fellings made which caused the grass to get out of control resulting in fierce fires which destroyed the original seedlings existing at the start. To this extent I am of the opinion that the silvicultural operations originally carried out in Moira Nadi were incorrect and have resulted in failure. During the past three years however very great attention has been given locally to this question of the natural regeneration of sal, and under Mr. Jacob to whom the greatest credit is due very great progress has been made chiefly from the uprooting of *Eupatorium* and rains weeding of the groups. In Dhanipara large patches of young sal are now established and hardly any more work will be necessary. There are also fully regenerated groups still in the whippy state in Khokapara, Dokhin, Sandubi and Modoki, many of which will certainly soon reach the established stage. In the hills under exceedingly difficult conditions in Borbakra, where sal is mixed with bamboo and much evergreen undergrowth, the patches are covered with seedlings but very little thatch has as yet made its appearance. The slopes of this compartment are probably unfit for sal and are best planted up with teak when it may be possible to get this done. In many of the plains areas not allotted to P.B.I., clearing the undergrowth, uprooting *Eupatorium* and removing rubbish in the overwood have resulted in complete reproduction which has come up under a moderate shelterwood. Success has also been obtained by jhuming in Borjuli. It is true that the yield has had to be curtailed but I am convinced from what I have seen that the present work has every promise of success and that the operations being carried out by Mr. Jacob may continue and be extended so far as this is possible. The realisation of the yield must follow silvicultural progress and subject to the progress in regeneration which is now being obtained regeneration fellings may continue but no more clear felled groups or strips should be attempted.

Bamba Block, Goalpara Division.—This type is fully described on pp. 61-64 of Champion's "Regeneration and Management of Sal." The main characteristics is the dense ground cover of *sau* grass. It was hoped by annual burning to turn this into thatch and with the advent of thatch to obtain sal regeneration and maintain this regeneration by early burning until the time came for fire-protection. So far no advance whatever in this direction has been achieved. The *sau* grass is as vigorous as ever and no sal regeneration has come up. In this connection, however, it must be recorded that there has been no general seed year for four years. I have seen the area felled over experimentally in Amguri block C. II, Haltugaon division, in 1919. Five sal trees were reserved as mother trees and everything else felled. There is now dense *Imperata* and *Saccharum narenga* grass with occasional small sal seedlings, typical Boko conditions, but there appears to be no hope of completing regeneration without assistance within any reasonable period of time. This gloom is somewhat relieved by the experiments carried out by Mr. R. N. De. In the above area, by rains weeding, he has obtained a complete patch of regeneration. Similarly in Bamba by pulling out *sau* grass in the rains he has been able to obtain regeneration. One of his experimental groups 4 years old is fully established. In view of what has been done I recommend that as soon as a seed year comes efforts should be concentrated on uprooting *sau* grass over one compartment of Bamba. From an examination of the surrounds of some of Mr. De's experimental areas it appears possible that even weeding in the second year, after recruitment takes place, may result in regeneration.

THREE YEARS IN GARO HILLS

By R. N. De, I.F.S.

Few Forest Divisions of Assam are more interesting than the Garo Hills. The natural scenery in some places surpasses in grandeur and beauty even the famous "resorts" of Europe, the varied and rich fauna containing some rare animals and birds, the flora with the

magnificent sal trees (*Shorea robusta*) towering up in the sky are some of the attractions too good to be missed by any one interested in the study of Nature. The hills are inhabited by a people called the Garos, who are a branch of the Tibeto-Burman races living in Assam, and are well worth a study.

2. Geographically, the Garo Hills are situated at the end of a range of hills jutting out of the main Range between Assam and Burma and form, together with the Khasia and Jaintia Hills, the main natural barrier between the Surma Valley and the Brahmaputra Valley. The district is situated roughly between 25°9′ and 26°1′ N. latitude, and between 89°49′ and 91°2′ E. longitude. The highest peak in Garo Hills is Nokrek having an elevation of 4,652 feet.

3. The natural scenery of the Garo Hills is one of the best in Assam. The writer has described some of them in his article "A trip down the Simsang Valley" in the January number of the *Indian Forester*, 1932. These hills are what may be called of plateau type, *i.e.*, they are usually flat at the top and eminently suitable for *jhumming*, *i.e.*, shifting cultivation. Towards the southern slope of the district, however, the Simsang, which is the chief river, flows over a series of cataracts and forms some magnificent valleys the sides of which are sheer precipices, often over a thousand feet in height. The well-known pitcher plant—*Nepenthes*—is common on these slopes. The limestone formations on the southern part of the district have produced that awe-inspiring cave called "Dobakol" or bats' cave where bats are found in thousands. It is a huge cave through which twenty men can easily walk side by side. A stream is flowing through it and big stalactites and stalagmites adorn the interior. The roof of the cave has the appearance of a dome with fantastic patterns here and there and no Garos or visitors are known to have ever explored the whole length of it. The Garos maintain that it is over half a mile in length, but this has neither been proved nor contradicted. The writer at the time of his visit could only explore a portion of the cave for want of time.

4. Isolated in their mountain homes by plains on all sides except the east, the Garos developed their own religion, manners, customs,

etc., undeterred by any outside influence. In olden times, communication with a neighbouring village was not very common, but the system of matriarchy, *i.e.*, mother being the unit of a house-hold, so to say, prevails both in Khasi and Jaintia, as well as in the Garo Hills. This will be described in detail later.

5. The Garos are divided into several tribes, but the Abeng, Awe and the Atongs are the most numerous. Each tribe differs from the other by some distinctive feature in dress, customs, etc. They are further sub-divided into three exogamous septs or "Katchis," *viz.*, Momin, Sangma and Marak, and except the Momin who are chiefly "Awes," these *septs* are present in all tribes, however much they might differ in language, custom, etc. An individual of one "Katchi" cannot marry another of the same "Katchi" or clan and the children always belong to the mother's clan. Thus a Sangma must marry a Marak or Momin girl, and his children will not be Sangmas, but Maraks or Momins. The writer when new to the Division was signing the Service Book of a newly appointed Garo subordinate and found the father of a "Sangma' put down as "Marak." Thinking it to be a mistake he returned it to his office and was told that Sangma's mother being a Sangma, he is called a Sangma although his father is a Marak.

6. They are, like most other aboriginal tribes, worshippers of Nature. A high hill, a big river, or a dense forest, is often regarded as the home of some "Mite" or spirit and worshipped. Owing to the activities of the American Baptist Mission, Garos have been converted into Christians for some years past and these have lost, as usual, most of their ancestral habits and customs along with the religion.

7. There are many "Mite" or spirits worshipped by the Garos, the more important of them are:—Tatara-Rabuga, Chorabudi, Salijong, Goera, Kalkamé, Susimé, Rukimé, Akrita, Nawang and Patigipa. Every spirit has a definite function. A "Sambasia" or sacrificial alter must be erected in every worship which is performed by a man called "Kamal," *i.e.*, priest. The writer while camping in the forest had the luck to witness the worship of Susimé, the Goddess of riches

and curer (and also causer) of blindness. It was to cure the sister of the "Kamal" from impending blindness. I was permitted to be present and saw the ceremony from beginning to end. A place in front of the house was cleared and a small bamboo frame and a few branches of bamboos were put up to make a "Sambasia." The "Kamal" sat in front uttering prayers and occasionally ringing a small bell. After a while a duck was sacrificed by cutting its throat and the "Sambasia" was smeared with its blood; it was then thrown at some distance. The "Kamal" went on with his worship while other members of the family prepared it for cooking. By the time the ceremony, which lasted about two hours, was over, the food was ready for distribution.

8. The Garos were head hunters before the administration was taken over by the Government in 1853, but the practice did not completely stop till 1876, when the Deputy Commissioner while camping at Rongrenggiri settled a number of blood-feuds and collected about 200 skulls of victims killed in raids and had them burnt. They used to raid the plains of Mymensingh and Goalpara Districts adjoining the Garo Hills and carry off victims to their jungle tracts. There were also blood-feuds between the different persons and villages and many people were killed in internal warfare.

9. The administration of the Garo Hills is conducted by a Deputy Commissioner, who is guided mostly by common sense and equity as the Indian Penal Code does not apply *in toto*. The Garo Hills regulations relating to forest matters are the basis of Forest Administration, but the Deputy Commissioner's words being as good as law, often the Forest Department is at a disadvantage. There are, however, some reserve forests in which the Forest Department can practise scientific forestry without any extraneous interference. For the purpose of administration, the whole of the Garo Hills proper is divided into four *mauzas* each of which is under the jurisdiction of a chief, called Laskar and each *mauza* is sub-divided into villages under a "Nokma" or Headman who is assisted by a Sardar in each village. For touring officers who are not provided with elephants, an order to Nakmas concerned called a "parwana" is essential for recruitment

of his labour, as a Garo does not ordinarily care to work for any one, unless there is an order of the Deputy Commissioner or he is hard-pressed for money to pay his house-tax. The Garos who practise *jhumming* or shifting cultivation which is the usual method of cultivation in the hills have to pay a house-tax of Rs. 4/8/- per house per year, and having very few necessities of life, he is not required to work hard for his livelihood. His field crop which consists chiefly of rice, corn, millet, is hardly sufficient for his requirements throughout the year. He has therefore to grow *cassava*, *arum* and other vegetables to supplement his food. The writer has often found people boiling *arum* or *cassava* for a meal and when questioned, they replied most casually that having no rice, they had to eat these to sustain life and appeared to be none the worse for it. They keep pigs, fowls and ducks, but the fowls are mostly sacrificed to various "Mite" or spirits. Garos eat almost all birds and other animals.

10. The Garo is generally reticent and their women folk are shy. Approach of a stranger near them has often caused a great panic and stampede, but once they get to know a stranger, they are very friendly, specially if one can talk the language of the people. The writer used to be surrounded by groups of people, both men and women asking for remedies of different ailments they were suffering from. A medicine box as part of one's equipment for occasional distribution never fails to attract popularity. The medicine should, however, be given with great caution, as a disaster can easily be caused by a poisonous or irritant drug. An anecdote of what may happen is recorded here. A Garo approached the writer for some medicine for a bad sore of his wife. Permanganate of potash crystals were given and solution to be made with water each time for washing was explained. After he had reached home, he put the crystals directly into the sore without making a solution. The result can be better imagined than described. All night the woman was in agony, as the permanganate was burning in the sore and in the morning when the writer happened to visit the village to see the *jhums* and enquired of the Garo as to how his wife was, the reply came that she was in great pain all night. Being nonplussed, the writer visited his patient and

Sambasia or altar for sacrifice.

The *Borang* or tree-house. Notice the tree in the background.

Off to the market.

Photos : R. N. De, I.F.S.

was dismayed to find that the whole quantity of crystals was applied on the sore without making any solution at all. The sore was, however, washed and dressed by the writer and directions were left to the sufferer for subsequent use and this time there was certainly no mistake.

11. A Garo has very few wants. He is very fond of dry fish and needs salt. He grows cotton, chillies and *arum* in his fields and by selling them in different markets, called " hats," situated mostly on the border of the hills, in the plains, he purchases dry fish and salt, and also his clothing. Attending a "hat" is an event very much looked for by the Garos. Those who live a long way from the markets often require 4 or 5 days for attending it and returning home, and have to camp in the forest on the roadside or in the market-place on the night previous to the market-day. Their merchandise consists mostly of cotton and lac, and a heavy load is usually carried.

The clothing of men is very scanty for he wears a strip of cloth called " Gando " about six inches wide, and six feet long passing round his waist and between his thighs. The women wear a strip of cloth called " Riking " about 18 inches wide round the waist extending upto the hip, and is tucked with a cane or a string at the ends, the length being just enough for both ends to meet on the thigh usually on the left side. Men generally wear a turban of dark blue or white cotton. Women do not usually cover the upper part of their body except only in cold weather. All Garos are not expert in weaving and it was in the south-western part of the district only that the writer saw some women weaving " Gando " and " Riking " for sale in the bazar. They do not generally take the trouble to make them at home, but buy these in the bazar.

12. Bedding of the Garos is a very simple affair. Their blanket is usually prepared out of the bast fibre of *Grewia tilifolia*, *Ficus rumphii* and *Artocarpus chaplasha* trees. The bark is separated from the tree and beaten with a mallet. The outer bark is broken into pieces and thrown away, but the bast is beaten into a sheet, and several pieces are sewn together to make a blanket. It is always carried by them on their " koksep," *i.e.*, the basket they carry on their back, if they have to sleep away from their house.

13. The houses of the Garos are usually built on a steep hillside so that part of the floor in front rests on the ground and the rest on a platform which is built higher and higher, as it extends down the slope in order to keep the platform level throughout. On the beams which are usually of wood, whole or split bamboos are put along the width and on them a split bamboo matting. The walls are also made of split bamboos and the roofing is made with thatching grass (*Imperata* spp.) bamboo or cane leaves. There are only two doors, a front and a back door, but no windows. Each house is generally divided into three parts, the front room which rests on the ground and is used for all public purposes is called "Nokkra." It contains the mortar and pestle for pounding rice, firewood, food grains, etc., and cattle, if there be any. Pigs are usually kept in an enclosure under the platform and when let loose in the day-time do the work of the scavenger. Then comes the room which is on the platform and is called "Nokganchi." This is the main room of the family and its space is earmarked for different purposes. The first post nearest the door has at its foot the abode of the spirits called "Maljuri," where all sacrifices to be done indoors are made. At the second post, where brew is made and pots of liquor are kept is called "Chusimra," next to which is the hearth. It is made by putting in a layer of earth on the bamboo platform. A small platform of bamboos called "Ongal" is also usually made over the fire place on which cooking pots, dry fish or meat, etc., are kept. Further on there is an empty space in which they take their food and unmarried girls sleep. Boys sleep in the "Nokpante" or the bachelors' house. The last room called "Nokdring" is used by the owner as his sleeping room which leads to an open verandah on the back side where the family often squat and dry their food grains and clothing.

Almost all Garos have two houses, one in the village and one in the field. During the rainy season when he has to weed and protect his crop from the depredation of wild animals, he lives in his house in the field called "Borang." It is built on a high platform usually on branches of trees. After the crop is harvested they return to their village. The fields being often at a considerable distance away

"GALMAK" dance in progress.

A Garo woman out for collecting firewood. Notice the tree-house—*Borang*—in the background.

A Garo house thatched with bamboo leaves.

Photos : R. N. De. I.F.S.

from the village, it is not unusual to see in course of one's tour many villages temporarily deserted. Every Garo village has a "Nokpante" or bachelors' house in which all boys and bachelors of the village live. These houses are often of large proportions and contain objects of Garo art, *e.g.*, wood carvings of crocodiles, tigers, horses, elephants. The "Nokpante" in Emangiri village is one of the best examples in Garo Hills.

14. Sword, spear and chopper are the principal Garo weapons and hardly a Garo can be seen without one or the other. The chopper is the common equipment of men and women when they go out of the house, but often men carry a sword or a spear. None of these weapons are, however, made in Garo Hills. On festive or ceremonial occasions, when they dance, a shield made of wood covered with skin or cane is held in the left hand and the sword in the right.

15. It has been stated before that matriarchy prevails in the Garo Hills. As members of the same class trace their origin through one common motherhood or clan, inheritance follows the female line. The daughter must therefore inherit the mothers' property, and in the absence of a daughter, another woman of the class is chosen by its members. Although a man cannot inherit the property, he has the full enjoyment of it during his lifetime. Thus a Nokma or a village headman is regarded as the owner of the lands of his village, although strictly speaking the property really belongs to his wife and he cannot alienate it. The property of the wife which a husband enjoys, is, however, controlled by his clan to a certain extent after the death of the husband, although he can never inherit or bequeath anything. He has the right to chose a "Nokrom," *i.e.*, a male representative to represent him after his death, and it is he who controls the property. Usually the "Nokrom" is the son of the husband's sister. He marries his maternal uncle's daughter and on the death of the maternal uncle marries his widow also. Thus the property which the daughter would inherit is controlled by the Nokrom, *i.e.*, husband's clan.

16. A girl usually chooses her husband. She does not make any direct proposal, but indicates her choice to her father or brother to bring about the alliance. Amongst some tribes it is customary to refuse to marry the girl and run away. A search party finds him out and brings him to the village from which he escapes a second time.

If he is really willing he marries the girl after he is caught the third time. Running away a third time means real unwillingness to marry. A man may marry as many wives as he likes, but no one usually marries more than two wives. No price is paid for the bride or bridegroom.

17. Birth, marriage, death, collection of harvest, etc., are all occasions for drinking and for sacrifice of pigs and fowls. There are some special occasions, however, in which dancing is greatly indulged in and the most important amongst them is the "Wangala," *i.e.*, the harvest festival. Wangala goes on for several days and every household is expected to provide food and drink to the merry-makers.

18. The Garos generally burn their dead. The corpse is laid out for two days and one night during which period all ceremonies are gone through and then it is cremated. After the cremation, the bones are collected and the "Abengs" build a small shrine of bamboo enclosure called "Delang" covered on all sides in which the pot containing the bone is deposited in their courtyard in front of the house. When the family gets ready for feasting and dancing for a second ceremony, the Delang is either opened and bones buried or it is set fire to and brunt, according to customs of different tribes. Most of the tribes put up memorial posts called "Kima" under the eaves of the houses as soon as possible after the cremation. A human face is often carved on the post to represent the face of the dead, but this is usually dispensed with in favour of rows of notches only. The Garos believe that after death their spirits must go to Chutmang, a high isolated hill on the south-east of the district. There they must live for a time till re-incarnated. In order to enable the dead body to undertake the journey a bull or a fowl is sacrificed to lead the dead to his resting place.

The above is a description of the Garos who live in the interior and do not come in contact with outsiders or have not been converted to Christianity. As with all races, contact with different people is rapidly changing their mode of life, customs, etc., and time is rapidly coming when many of their practices will disappear. The writer who spent over three years of his service in the Garo Hills found them a lovable people and hopes that they will long continue to be so inspite of the present day "civilisation."

DHUBRI, ASSAM :
6th January 1936.

A NOTE ON TIMBER EXTRACTION IN THE CHITTAGONG HILL TRACTS, BENGAL

By R. I. Macalpine, D.F.O.,
Chittagong Hill Tracts District.

The forests of the Kassalong Range of this Division have previously been noted on by various observers and a detailed description would be out of place here.

From the point of view of utilization, however, a brief note on the more commercially valuable trees is perhaps necessary.

The most striking tree without doubt is gurjan (*Dipterocarpus pilosus and D. turbinatus*). These are gregarious and together with the so far unsaleable civit (*Swintonia floribunda*) tower above the general mass of miscellaneous species below.

Of these latter, pride of place must be given to *tali* (*Dichopsis polyantha*) which finds a ready local sale. This species too is almost gregarious. Next comes *pitraj* (*Amoora* spp.), but this practically ends the list of species which are available in any quantity. *Chapalish* (*Artocarpus chaplasha*) trees though few in number are of big girths and give big volumes. *Jarul* (*Lagerstroemia flos-reginae*), *kambdeb* (*Calophyllum* sp.), *nageswar* (*Mesua ferrea*), *jam* (*Eugenia* spp.), *gondroi* (*Cinnamomum cecidodaphne*) and *banspatta* (*Podocarpus neriifolia*) are found in small and variable quantities, as also such species as *pitali* (*Trewia nudiflora*), *chundal* (*Tetrameles nudiflora*) and *bhola batana* (probably Lauraceae) which are sometimes saleable.

The rest of the crop comprises numerous species generally associated with evergreen forests of this locality which are completely unsaleable.

The saleable species, therefore, form a very small proportion of the total crop and this naturally affects extraction considerably. To get out large quantities of timber requires large areas.

The Kassalong Range lies in the valley of the Kassalong river, one of the tributaries of the Karnaphuli on the mouth of which the Port of Chittagong stands. The extraction area is some 110 miles

from Chittagong, and it is hence that all timber finally finds its way for sale.

All transport is water-borne (there not being a single cart road in the district and no wheeled traffic whatever). This is all to the good as far as costs of carriage of timber are concerned, except for the fact that these rivers, during the dry season, dry up considerably and there is not sufficient water to carry timber rafts. There is therefore feverish activity during the rains when perforce all extraction to Chittagong must take place.

Prior to 1931-32 such departmental extraction that occurred was small in extent, and the major sales were on account of timber sold at stump to traders. This trade was however fitful, and although plantations were started as far back as 1920, the amount of timber extracted was small and the waste must have been colossal. Contractors were frightened to come so far from their homes and this, coupled with the playful habit of the local cutter taking advances and then bolting, made any expansion of timber operations out of the question.

In 1931-32, therefore, it was decided to go in for extensive departmental timber operations. The following details of timber extracted per acre is interesting :—

Year.		*C.ft. per acre*
1927-28	..	48
1928-29	..	50
1929-30	..	57
1930-31	..	122
1931-32	..	83
1932-33	..	21
1933-34	..	115
1934-35	..	207
1935-36	..	200 (approx.)

During the first years of departmental extraction, manual labour only was employed. Labour was unskilled and manual power was insufficient to tackle the large logs which were accordingly left to rot or to be burned during *taungya* operations.

This was forcibly commented on by Mr. Jeston Homfray, Conservator of Forests, and the whole question of extraction was examined. He considered the only solution was mechanical extraction, a startling departure for a most conservative Conservator.

Various suggestions were examined and it was eventually decided to purchase a caterpillar tractor which after lengthy correspondence was done.

The history of this machine thereafter for a period was almost Gilbertian. A 30 h. p. tractor fitted with a Hyster winch was consigned to Chittagong. Here the first " event " in its interesting history occurred. It was lifted from the steamer and loaded on to a raft, but a mistake either in the timing of the tide or delay caused the unloading to coincide with the turn of the tide and the raft *plus* tractor floated gently but firmly towards the open sea, and was only regained with difficulty.

The next step was to transport it the 100 odd miles to Mainimukh which was done without any further alarming experiences.

The stage was now set for the " try out." A demonstration was arranged and representatives of the Tractor Company and Forest Officers proceeded to Mainimukh. Logs were in readiness but the first attempts met with no success. The logs were too big. Attempts were then made with a skidding pan but these too were unsuccessful, the pan tipping over at the smallest irregularity on the ground. It should be remembered that the tractor was purchased to extract logs too big to be handled by men. Further the tractor was only a 30 h. p. machine and estimates had been prepared for a 60 h. p. model.

The next step was the provision of a logging boom—as it turned out later a step in the right direction—but in the meantime the tractor remained idle (if " idle " is the right word in view of the events which followed).

In 1934, while it was being removed from one place to another it took a high dive over a bridge and settled firmly in soft mud. Frantic telegrams were sent for cranes, but it was pulled out eventually without recourse to these by the help of men and the " Chakma kol " (a Heath Robinsonian " home-made " windlass). The Tractor

Company were asked to survey the damage which may have resulted from this accident. Our troubles were however far from over. A cheerful local, thinking, it is alleged, that petrol was good for rheumatism, decided one night to get some from the carburettor. He apparently could not see what he was doing and lit a match to aid him in his quest. The resultant conflagration would have done justice to the Jubilee celebrations.

More expense and labour eventually put the tractor in order again and stock was taken of the situation.

Correspondence resulted in 1934 in the agents undertaking with their own operators a demonstration on a contract basis. Briefly they were to be paid -/3/- per c.ft. of timber successfully extracted from stump to Ghat on an average lead of 500 yards. They were to make any roads required at their own expense and also pay all running costs such as fuel, etc. They were to be responsible for the safety of the tractor and return it to us in good condition.

Owing to some unfortunate delay, the representatives were not able to start work until the 22nd May 1934. A coupe had been selected and logs were in readiness.

From the welter of correspondence on the subject it came to light that it was claimed that the tractor would haul logs of 1½ tons. This point had obviously never been raised by the representatives in the previous trials and was something in the nature of a "knock out," as most of our timber was of big girths, and lengths of under 18 feet could not normally be sold.

A further complication arose when the representatives stated that they were talking in terms of actual tons and not timber tons. Just to make things more difficult still they talked of American tons of 2,000 lbs. These points fortunately did not arise until the representatives were at Mainimukh and we were able to compromise to the effect that they would try their best to get out every log. If it was found that a log was too big to tackle it was to be left. No logs under 18 feet in length were to be extracted.

The first day's work proved that much more than 1½ tons (actual) could be negotiated and in the course of the trial a log weighing 3·9

tons was successfully hauled out of a nullah where no other agency would have succeeded.

This trial was brought to an abrupt conclusion by heavy rain which made footing impossible and it was decided to bring the operations to an end. In all some 5,500 c.ft. had been extracted over an average lead of 389 yards. While the actual amount of timber extracted was small, and the period of the trial was short, we had, nevertheless, obtained some ideas on the working of the tractor.

Accordingly the following cold weather we arranged a "full dress" contract with the agents on the same terms as before but with the added proviso that the contract rate would be proportionate to the average lead, at -/3/- per c.ft. on 500 yards. We guaranteed a minimum of 30,000 c.ft. and a maximum of 50,000 c.ft.

Work had commenced on the 18th January 1935 and continued till the 18th March by which time 30,158 c.ft. had been extracted on an average lead of just over 500 yards.

No serious defects were evident in the mechanism of the tractor. It had been working at full speed the whole time, and as far as I know, no breakdowns of a serious nature occurred.

The boom was responsible for a few breakages by turning over when it struck big bumps, but as the tractor drawbar gave on such occasions, and is both inexpensive and easy to replace, this is not a serious defect. The total cost of replacements will not, I believe, exceed Rs. 500, a small item when it is considered how much timber was extracted, in fact this represents an addition of only 3 pies (approximately) per c.ft.

While the results noted above, are interesting in view of our failures in the past, the chief difficulty still remains. How can we extract the very large logs ? In the case of gurjan, 300 c.ft. logs are the rule, rather than the exception. So far no agency tried can deal with these sizes unless they are on the river bank. Whether skidders or even a 75 h. p. Diesel tractor is the solution or not, I am not prepared to say.

Extraction by Manual Labour.—This form of extraction has much to commend it. Firstly, there is no depreciation on capital cost, secondly, there is no fear of breakdowns and consequent cessation of work. There are however numerous disadvantages. The scope is limited, big trees cannot be extracted, trees in "blind" depressions cannot be taken uphill, and so on. Perhaps, however, the chief disadvantage is that such work must of necessity be done during the rains, when side streams can be used for rafting. With the tractor this is not necessary, as extraction to the main river can be done during the cold weather and all that remains is for floods to come for rafting to the sale depot.

It would seem that the ideal would be to combine both mechanical and manual extraction suiting each to the particular locality best suited to each. This is the procedure to be adopted in future.

Elephant Extraction.—Two touring elephants stationed at Mainimukh were put on to extraction during the rains of 1934. Neither had had any training in this work before, and one turned out to be completely useless for the job. They, nevertheless, were able to get out some 5,500 c.ft. of mostly small timber over 61 working days and proved that elephants too could be fitted into the scheme.

Costs.—The following comparison of costs for each agency is of interest—

Year.	C.ft. extracted.	Average cost per c. ft.		
	Manual Labour.			
		Rs.	a.	p.
1934-35	.. 17,299	0	2	7·8
1935-36	.. 26,359	0	2	5·4
	Tractor.			
1935-36	.. 30,158	0	1	1·6*
	Elephants.			
1934-35	.. 5,022	0	1	2·5

**Note.*—In calculating this cost, the actual working costs including cost of road, fuel, pay of operator, etc., but not depreciation or interest on capital cost, has been included.

It will be seen that the tractor comes very well out of this, but it should not be forgotten that the machine was in the hands of experienced operators. It still remains to be seen whether we shall have the same success working departmentally.

Perhaps, as various agencies work in various localities the fairest way of comparing costs are by "ton-miles." These figures are being collected, but require a period of years to enable an accurate figure to be compiled. For instance, although a very great increase in the output of timber occurred this year, owing to a very high flood which inundated the whole area, extraction by manual labour was easy, and the actual "ton-mile" figure small, as the flood allowed extraction over what would normally be impossible routes. Figures for normal years are, however, as follows—

		Rs.	a.	p.	
Manual labour	..	41	9	7	per ton-mile.
Tractor	..	20	0	0	do. (approx.)
Elephants	..	12	15	6	do.

Other costs.—The above costs are for extraction from stump to rafting site on the main river. To these must be added the following—

		Rs.	a.	p.	
Felling and logging	..	0	0	3	per c.ft.
Rafting and extraction to Chandraghona	..	0	1	3	do.
Stopping charge at Chandraghona	..	0	0	2·4	do.
Rafting from Chandraghona to Chittagong	..	0	0	3	do.
Total	..	0	1	11·4	or say Re. -/2/-

It will be seen therefore that even with the most expensive form of extraction the costs from Mainimukh to Chittagong do not exceed a maximum of Re. -/4/8 per c.ft. for a distance of 110 miles.

Markets.—The chief, and in fact, only market is Chittagong. Much of the timber sold here is for local consumption, freights precluding an entry into other markets such as Calcutta.

In recent years, however, we have been able to get some of our timber sold outside Chittagong, mainly to Railways. The Assam-Bengal Railway has been a steady if small buyer at Chittagong.

Such timbers as *jarul*, *tali*, *pitraj*, etc., are apparently saleable in any quantity locally. In the past gurjan had a good sale, but with trade depression, and also the corruption of the traders who sold this species as "Chittagong jarul," this market seems to have failed.

The absence of any well appointed mills makes it impossible to supply sawn timber and it is here perhaps that the future lies for gurjan for the Home market. Shipping facilities are present and as extraction is cheap it seems unfortunate that we cannot make use of the opportunities offered. This year however has shown a distinct improvement in that the total output of gurjan has been disposed of to a Chittagong firm for a Calcutta order. The price obtained is low, but as there is likely to be some 40,000 c.ft. available, the sale is a valuable one.

It should also be noted that the materials used in rafting are also easily saleable. These consist of bamboos and "jungly" posts, bamboo fetching anything from Rs. 10 to 17 per thousand. When it is realised that some 3 bamboos per c.ft. of timber are required for rafting, the revenue by their sale is not inconsiderable.

XYLIA XYLOCARPA FOR SLEEPERS

BY E. K. KRISHNAN, E.A.C.F., S. KANARA

South Mangalore Forest Division has annually to supply about 6,000 B. G. and about 2,000 M. G. sleepers to the Railway. The trees felled for this purpose are *Hopea parviflora* and these are obtained from Government unreserved forests—the exploitable girth being 4 ft. and above. Owing to the depletion of the stock of trees of these girth classes from this source, it was decided for the first time to exploit *Xylia xylocarpa* trees from the unreserved forests of this Division to meet the annual supply.

It is well known that *Xylia*, unlike *Hopea*, is prone to splitting, especially when converted in the green and sawn up into scantlings. The indent for the supply of sleepers of this timber was received in July last and the supply had to be made as quickiy as possible. This left the management little time to fell the *Xylia* logs in advance and to season them before conversion. It was decided therefore to hasten the process of seasoning by killing the trees by girdling or by applying Atlas solution.

As this method of conversion was in the nature of an experiment, it was decided for purposes of comparison to watch carefully what degree of immunity to cracking, if any, was achieved by killing *Xylia* trees in advance. Two methods of killing were therefore decided upon. Firstly, by simply girdling the trees and, secondly, by applying Atlas solution on a raw wound round the stem. For purposes of control an equal number of trees was taken for conversion in the green state.

Fifty trees of each class were marked. They were girdled or treated with Atlas solution between the 8th and 13th August 1935. During felling on 4th September 1935 some of the marked trees were found to be hollow and were therefore rejected. The following statement shows the result of conversion on 27th October 1935—

Trees girdled and treated with Atlas solution.	Trees simply girdled.	Trees untreated and converted in the green state.
Trees marked .. 50 Unsound when felled 3 Gross yield of 47 trees—49 logs of 847 c.ft.	Trees marked .. 50 Unsound when felled 12 Gross yield of 38 trees—42 logs of 756 c.ft.	Trees marked .. 50 Unsound when felled 2 Gross yield of 48 trees—51 logs of 918 c.ft.
Net Yield. B. G. 78 .. 243·7 c.ft. M. G. 74 .. 111·0 c.ft. Scantlings 37 32·7 Total .. 387·4 c.ft.	*Net Yield.* B. G. 67 .. 209·4 M. G. 51 .. 75·5 Scantlings 25 20·1 Total .. 305·0 c.ft.	*Net Yield.* B. G. 74 .. 231·3 M. G. 52 .. 78·0 Scantlings 22 22·3 Total .. 331·6 c.ft.
Percentage of net to gross yield .. 45·5	Percentage of net to gross yield .. 40·5	Percentage of net to gross yield .. 36·2

Though the experiment is on a very small scale, there is still reason to conclude that the wastage due to conversion of *Xylia* trees in the green state is considerable and that it is more economical to convert the trees after seasoning.

It would be interesting to hear the results of experiments conducted in other districts on these lines—particularly if they have been undertaken on a large scale.

7th December 1935.

NOTE BY THE FOREST ECONOMIST

The experiment is interesting, but is certainly not conclusive. The actual amount of "seasoning" which would be completed between the 8th August and the 4th September in standing trees should be negligible, and it is highly improbable that such a short period of "seasoning" would have any appreciable effect on the subsequent qualities of the wood. Standing trees whether girdled or not dry out very slowly.

An experiment on girdled deodar is now going on in North India, and sleepers cut from trees girdled 2 years ago are now being received at the Punjab depots. These sleepers are being carefully inspected and the rejections recorded in order to see whether girdling has had any appreciable effect.

The Forest Research Institute will always be pleased to hear of similar experiments elsewhere, but the period after girdling and before felling should be such that it is possible for it to affect the later seasoning qualities of the wood.

H. TROTTER,
Forest Economist,
Forest Research Institute.

REVIEWS

THE DUKE FOREST

By C. F. Korstian and W. Maugham

Forest Bulletin No. 1. *Duke University, Durham, North Carolina, June* 1935.

The Duke University of North Carolina has as part of its forest school programme acquired a tract of land and is developing it as a demonstration forest for the teaching of forestry both to undergraduates and to local forest owners. This forest comprises about 3,300 acres in one block adjacent to the university *campus*, and two smaller blocks further off. These are being developed under a combination of demonstration and research,—demonstration of the more obvious necessities of silviculture such as thinning, cleaning, planting, pruning, protection against fire and insects, and research in many forestry, biology and soil problems sponsored by the university staff.

Much of the ground taken over holds pine which has seeded naturally on abandoned fields, for with land plentiful and labour cheap, the agricultural methods of the southern planter have completely destroyed the fertility of the soil on large areas. This, combined with the recent economic depression has served to put much of it out of cultivation. The area in this respect is representative of a very much larger tract of the Piedmont plateau, which runs through the Carolinas and Virginia more or less parallel with the eastern seaboard of the southern states. A fine sandy loam overlies a waxy clay subsoil, and with the heavy surface wash which develops on exposed fallow, and on the uncultivated surface of abandoned fields, the top soil is quickly lost and gullying bites deep into the underlying clays. The attention which is being paid to erosion problems by the Duke forest staff is an indication of the tremendous importance of this subject to the southern farmers and land-owners. Much of the land which once produced excellent hardwoods before being farmed is so depleted by cultivation and erosion that now only the less exacting pines can succeed on it.

The annual rainfall is 47 inches, well distributed between the four seasons, but heaviest in July and August and scant enough in spring and autumn to raise a very definite fire hazard. The forest is extraordinarily varied and is described under fifteen different types, the most important of which are the loblolly and shortleaf pines (*Pinus taeda* and *echinata*) on the drier uplands, and their mixture with various oaks such as *Quercus alba, stellata, rubra, velutina* and *coccinea*. Then there are the pure oak woods of the cool moist situations with a very interesting and varied undergrowth of *Cornus*, juniper, *Oxydendrum*, *Acer*, *Ostrya*, *Cercis*, and persimmon. The bottom lands along the rivers have as their chief species *Liquidambar* or red gum, and *Lyriodendron*, locally known as yellow poplar, but possibly better known in Europe as the tulip tree ; these combine with many other broadleaf species to form magnificent tall forests somewhat reminiscent of the riverain stands of the Buxa duars. The prolific growth and easy climatic conditions of North Carolina can be judged from the list of trees shown as "introduced species now more or less naturalised" :—*Ailanthus, Catalpa, Melia azedarach, Lagerstroemia indica, Robinia pseudacacia, Gleditsia triacanthos, Albizzia julibrissin, Papyrius paperifera, Paulownia,* and the European white poplar.

Owners of timber land in the southern states have been slow to take any interest in the management of their woods and a demonstration forest is therefore badly needed there. Little is known of silvicultural methods suitable for the great variety of types. The intimate mixture of types is well shown by the fact that each compartment of Duke forest, averaging 40 acres in size, has an average of 14·5 forest "stands" distributed in it. In this connexion the accurate and limited use of the word "stand" to designate the extent of *one woodland type* forming a homogeneous crop is an improvement on the usual slipshod use of this word in forestry.

Much emphasis is put on the keeping of forest records in a manner which will be of most service to future workers, and one useful idea is the concentration of all the data usually shown in a "compartment history file" on a letter-size card-index, with the description and

all data of site, soil, stocking, and increment on one side, and on the other a running record of all operations. For the purpose of regulating the annual yield the forest is allocated to four "working groups"—a term which strikes one as being a very poor substitute for the more commonly used "working circle." The four "working groups" are for pine, pine-hardwood, upland hardwood and bottom-land hardwood, the growing stock in the last three being largely unevenaged and consisting largely of overmature and fire-damaged trees embedded amongst younger growth. The immediate fellings are therefore to be in these three groups, the younger evenaged pine crops being treated under thinnings of varying intensity. The science of thinning however appears to be in an embryo stage in North Carolina, judging by this footnote to a photo: "On this area the stand was thinned from above, with only the largest and best trees being removed. This practice is one of the mistakes commonly made in handling pine forests in this region." The spiritual fathers of *éclaircie par le haut* might well turn in their French graves, and the living protagonists of crown thinnings will blanch over such savagery! In justice to the Duke foresters, however, it is only fair to say that this demonstration is in line with their professed intention to include in their forest examples of *undesirable* methods.

The reforestation programme by planting seems excessive zeal in view of a photograph showing natural regeneration on an abandoned field of taeda pine, 7 years old, 13 feet in height, and with a density varying from 1,000 to 22,000 stems per acre,—the sort of thing the average D. F. O. in India dreams about after a particularly good celebration dinner! Planting is however fully justified by the necessity of establishing a vegetative cover as soon as possible on all such land to reduce the amount of erosion. The great vulnerability of these light Piedmont plateau soils is really most spectacular, and the reviewer's recent visit to a Soil Erosion Service project on the South Tiger River, not many miles from the Duke forest, reminded him most painfully of Etawah at its worst! The native taeda and echinata pines and *Robinia pseudacacia* are the principal species used in this planting, the value of the last being in producing a mass of surface

roots quickly and in helping the pines in a more rapid building of soil fertility.

This university forest also does duty as a state game preserve, and it is already proving its value in this direction in a countryside which has been shot and hunted until its naturally rich fauna of hare, squirrel, opossum, raccoon, fox, quail and wild turkey have been all but exterminated.

R. M. G.

CRITICAL PLANTS OF THE UPPER GREAT LAKES REGION OF ONTARIO AND MICHIGAN

BY M. L. FERNALD, GRAY HERBARIUM, HARVARD UNIVERSITY.

(*Reprinted from "Rhodora," Vol.* 37, *June—September* 1935.)

An instance of the botany of living plants being used as an aid to geology is described in this monograph, and must surely be rather unusual. The common interpretation of the geological history of the North-Eastern United States is that Michigan and the southern shores of the great lakes along the Canadian border were swept by a tremendous glaciation in Pleistocene times, so completely that none of the previous land surface survived. This view has been generally accepted by geologists, but the botanical evidence now put forward is likely to make them change their minds. Dr. Fernald has demonstrated that many pockets of growing plants now exist, which must have been in undisturbed possession of their habitat since before this glacial age.

These particular plants are found on rotted rock debris deposits on the tops of rocky plateaux, and their presence on such undisturbed sites proves that the ice-flow, instead of smothering the entire country to a depth of 6,000 feet, as has been popularly imagined, must have been merely a shallow valley flow, leaving these plateaux unaltered above them. As an example of the type of plant providing this evidence we might take *Pteridium aquilinum* var. *lanuginosum*, the common bracken fern of North America ; it occurs in many of the western mountains from Alaska to Western Texas, but in the eastern

half of the continent it occurs only in a few isolated patches such as these rocky plateaux around Lake Superior.

Dr. Fernald has demonstrated that there exists on top of a series of high bluffs and escarpments a rotted and angular mantle of rock which must have remained *in situ* when the geologists would have us believe that all such areas were scrubbed clean by the ice and redeposited with transported drift rock. He shows that these " driftless areas " have maintained colonies of the formerly widespread Tertiary flora of which the bracken is an example. Under active glaciation this flora has been cleared out from most of this country and replaced by a younger and more aggressive set of plants, but the presence of these driftless areas, hitherto unrecognised, proves that glaciation cannot have been on as wholesale a scale as has been generally supposed.

R.M.G.

EXTRACTS

THE MANUFACTURE OF HUMUS BY THE INDORE PROCESS

BY SIR ALBERT HOWARD, C.I.E.

(Formerly Director of the Institute of Plant Industry, Indore, and Agricultural Adviser to States in Central India and Rajputana.)

The advantage of a continuous supply of leaf mould (humus) for such crops as tea, coffee, sugar, coconuts and rubber needs no argument. It is well known to every planter.

The object of this article is to draw the attention of the plantation industries of the East to a composting system—known as the Indore process—by which the waste products of the estate can, at small cost, be converted into valuable humus. This method, the outcome of 25 years' work, was perfected at the Institute of Plant Industry, Indore, Central India, and is described by Messrs. Howard and Wad in *The Waste Products of Agriculture: Their Utilization as Humus*, published in 1931 by the Oxford University Press, Bombay.

The Indore method has been taken up at many centres all over the world, including most of the coffee estates in Kenya and Tanganyika and many of the tea estates in India and Ceylon. It has proved to be a thoroughly elastic method, suitable for a variety of climates, for a wide range of crops and capable of being carried out by the most primitive types of labour. Readers of this journal interested in the process can obtain copies of an illustrated paper of instructions on application to the writer of this article to 14, Liskeard Gardens, Blackheath, London, S. E. 3.

THE COMPOSTING AREA

The first requirement of the process is an area of land, conveniently situated for supervision. At Indore this consists of 33 pits, each 30 ft. by 14 ft. and 2 ft. deep, with sloping side, arranged for the easy passage of loaded carts. The pits are in pairs, with a space 12 ft. wide between each pair. Water is provided by a tank, holding 3,200 gallons, 4 ft. above the ground to provide the necessary head. The water is led by 1·5 in. pipes from the tank to eight taps, to which the armoured hose (fitted with a suitable nozzle) can be screwed. Each tap serves six pits.

WASTE PRODUCTS

The materials needed for making humus are the following —

(1) *Mixed Plant Residues.*—All available vegetable wastes from the estate—such as weeds, green-manure, cane trash, fallen leaves, light prunings, water hyacinth, trimmings from road-sides and hedges, straw, chaff, wood shavings, saw-dust, waste paper, old gunny bags and so forth—are collected and stacked. All hard woody materials are either crushed (by being placed on the estate roads and broken up by the traffic) or cut into short lengths by a chaff-cutter. *All fresh green materials—such as weeds, green-manure and water hyacinth—must be withered before stacking.* To ensure even mixture, the stacked material is removed from one end of the stack either to the pits direct or as bedding for the work cattle.

(2) *Cattle, Buffalo and Horse Dung* (including all soiled bedding from under the animals).

(3) *Urine Earth.*—The earth under the animals should be dug out to a depth of six inches every three months, powdered in a mortar mill and stored under cover near the compost pits. Fresh earth is then added to replace the urine earth which has been removed.

(4) *Wood Ashes.*—These are useful for neutralising acidity and for increasing the potash content of the final product.

(5) *Water and Air.*—These are essential for the fungi and bacteria which manufacture humus.

CHARGING THE PITS

The pits are charged as follows—A broad plank is first laid across the pits so that they can be filled without consolidating the material by trampling. A layer about 3 inches deep of mixed plant residues is first spread by a rake lightly and evenly over the floor of the pit. This is well sprinkled with mixture of wood ashes (if available) and urine earth. A layer about 2 inches deep of broken up dung and soiled bedding follows. The contents are then well moistened (not flooded) with

the hose. The charging and watering processes are continued till the pit is filled to a depth of 30 inches in all, finishing off with a layer of dung and soiled bedding followed by a good sprinkling of urine earth, ashes and water. The pit is watered in the evening and again the next morning. By giving the first watering in three stages, time is given to the mixture to absorb sufficient moisture to start the intense fermentation which soon sets in. Rapid shrinking then takes place and the contents of the pit contract to the ground level.

WATERING

The subsequent waterings are most important. The pits should be watered once a week, and at the time of the first, second and third turns.

TURNING

To ensure uniform mixture and decay and to provide the air and water needed by the organisms, the material is turned three times—

First turn.—This is done when the pit is 10 to 14 days old. Half the pit is dug out with the fork, the contents are moistened and doubled lengthwise over the undisturbed half. The half-turned heap is then well watered.

Second turn.—Fourteen days after the first-turn, the material is again turned, watered and piled up loosely along the empty half of the pit.

Third turn.—When the pits are two months old, the dark crumbling material is moistened and stacked on the surface in rectangular heaps—10 ft. broad at the base, 9 ft. wide at the top and 3·5 ft. high—to ripen for a month, when it is ready for the fields. During the ripening period, a good deal of extra nitrogen is obtained by fixation from the atmosphere. When the humus is carefully made, the total gain of nitrogen may be as much as 25 per cent.

HUMUS MANUFACTURE DURING THE MONSOON

During the monsoon, when the pits are often full of water, humus must be made in heaps on the surface. Where the rainfall is moderate, the heaps should be 8 ft. by 8 ft. at the bottom and 7 ft. by 7 ft. at the top, and 2 ft. in height. Where the monsoon is very heavy, composting should either be carried out under cover, or if this is impossible, the manufacture may have to be suspended during the period of very high rainfall—June to September.

TESTING THE EFFICIENCY OF THE PROCESS

The efficiency of the process can be tested by observation and without recourse to chemical or biological analysis. During the first month fungi are engaged in breaking down the mixed wastes. The heaps should be a mass of white fungoid growth and the temperature should be high. If a metal rod is inserted at this stage, it should be hot to the touch when withdrawn. After the third week the mass darkens in colour and becomes crumbly. Bacteria from now onwards take an increasing share in the process.

If at any time the fermentation stops and the pits cool, want of moisture is the most likely cause. Should the heaps begin to smell, flies will be at once attracted

and will proceed to lay eggs followed by the development of maggots in large numbers. This only happens when there is some interference with the air supply. The remedy is to turn the heap at once and to add dung and ashes. The chief causes of insufficient aeration are excessive trampling, the addition of too much urine-earth and ashes, over-watering or failure to turn the mass at the proper times.

APPLYING HUMUS TO THE LAND

Humus can be applied to land at the rate of 5 to 10 tons per acre and mixed with the surface soil at any time of the year except during the monsoon, when it is almost certain to be washed away and lost. The best results are obtained during the hot weather and at the close of the rainy season. When applied to the land after the rains, care should be taken to conserve the soil moisture.

THE FINISHED HUMUS

Humus consists of a dark, finely divided rich earth containing about 1 per cent. of nitrogen, about 0·5 per cent. of phosphoric acid and about 3·0 per cent. of potash. The composition naturally varies to some extent with the locality and the materials used. On the tea estates in Travancore, where compost is being made on the large scale under Dr. C. R. Harler's supervision at an average cost of about Rs. 1/8/- per ton, the nitrogen content is as high as 1·3 per cent., the phosphoric acid and potash figures being very like those obtained at Indore. The value of humus, however, does not depend on chemical composition alone. This is only a part of the story. Humus improves the texture and water-holding capacity of the soil and also furnishes good materials for the soil organisms. The improvement of the physical texture of the soil and the stimulation of the soil organisms are, perhaps, more important than the nitrogen, phosphoric acid and potash supplied to the land.

CONVERSION OF MUNICIPAL WASTES

The Indore process has been successfully applied to the conversion of Municipal wastes (town refuse and night-soil) by Messrs. Jackson and Wad. Their results are to be found in a paper published in the *Indian Medical Gazette* of February 1934, which has been reprinted as one of the bulletins of the Institute of Plant Industry, Indore, Central India. Copies can be obtained on application to the Director of the Institute. Adopted originally at three centres at Indore in 1933—the Residency Area, Indore City and the Malwa Bhil Crops—the method has since spread to other Central India and Rajputana States, and to a number of centres in British India, including Military Cantonments and Municipalities. The feature of the system is the great saving which takes place in the cost of disposal of these Municipal wastes. The sale-proceeds of the resulting humus, for which there is a keen demand, considerably exceeds the cost of conversion.

Perhaps the most interesting development which has occurred in the utilization of urban wastes is that at Nairobi, in Kenya, where the Express Transport Company has set up a commercial plant for converting the miscellaneous wastes of the town into a very valuable manure. The raw materials used are—coffee parchment, *boma* manure, tannery waste, slaughter-house refuse, horn and hoof, bones, cotton seed

residues, chaff, wood ashes and crude limestone. These are finely ground when necessary, mixed in a rotary mixer, moistened and fermented for 90 days, according to the technique laid down in the *Waste Products of Agriculture.*

A very useful organic fertiliser is obtained, containing the following percentages: organic matter 62·15, nitrogen 1·5, phosphoric acid 1·5, potash 1·5, lime 4·0.

The capacity of the factory is 20 tons a day ; in 1934 the sales amounted to 3,500 tons ; the price per ton at the fermenting pits is 14 shillings.

The Managing Director in a letter dated Nairobi, 26th September, 1935, reported—

"The results obtained on controlled experimental plots, flowers, vegetables, maize, grasslands and coffee have, frankly, been amazing."

As one of the great needs of most of the plantation industries is a reserve supply of fermented organic matter of good quality at a reasonable price, this Kenya enterprise could with advantage be copied at many urban centres in the East.

ADVANTAGES OF THE INDORE PROCESS

The advantages which are certain to follow the adoption of the Indore process by the plantation industries of the East are these—

1. *Costs will be Reduced.*—The substitution of artificial manures, imported from abroad, by humus made on the spot from the waste products of the estate and by the ordinary labour force has already lowered the cost of production of coffee in Kenya and Tanganyika. A similar result is beginning to be obtained on some of the tea estates in India and Ceylon. The exact saving can easily be calculated when the following facts are known : the cost of making and applying humus ; its chemical composition ; the cost of importing and applying equivalent amounts of nitrogen, phosphates and potash in the form of artificial manures.

2. *Improvement in the Moisture-retaining Capacity of the Soil.*—Humus helps the soil to withstand drought.

3. *Increase in Yield and Quality.*—Not only will humus improve the yield per acre, but it is likely to lead to better quality. This has already taken place in coffee. There is every reason to believe that similar results will be obtained in tea.

"Capital," Indian Industries, Trade and Transport Supplement, December 1935).

THE PLACE OF THINNING IN WATTLE SILVICULTURE AND ITS BEARING ON THE MANAGEMENT OF EXOTIC CONIFERS

A REVIEW and SUMMARY BY C. C. ROBERTSON of an article by I. J. CRAIB, M.F., Ph.D., published in the *Zeitschrift fur Weltforstwirtschaft.* (Bd. I. Heft 2/3. Tharandt, Saxony, 1934): prefaced by a NOTE by R. C. BOURNE, *Imperial Forestry Institute, Oxford.*

PREFATORY NOTE

THE research undertaken by I. J. Craib on the cultivation of wattle (*Acacia mollissima* and *decurrens*) in South Africa, the results of which have recently been published in English in the *Review of World's Forestry*, is summarized and reviewed in the following article by C. C. Robertson. The work has conclusively shown, in comparison with the treatment hitherto practised by wattle-growers, that the production

of bark and wood can be greatly increased by early and heavy thinnings. The height growth of individual trees is so rapid (30-40 feet in three years), and their intolerance of competition is so great, that the revised practice involves thinning out the original crop at six, twelve and eighteen months almost to its final espacement. The object of this drastic treatment is to eliminate crown competition and to ensure that the final crop trees are absolutely dominant, with maximum crown development. By this means " there is reason to anticipate a normal yield of 12 to 16 tons of dry bark per acre in sixteen years as compared with the 4 tons in eight years, which is regarded as a satisfactory yield to-day."

The principal point which Craib desires to establish, in consequence of his observations on wattle, is that the crown of an intolerant species, once restricted, will never *fully* respond to thinning, or in other words, that a dominant tree which has survived competition is relatively suppressed in terms of absolute dominance. Absolute dominance, in the case of an intolerant species, may be envisaged by picturing a tree intermediate in form between a dominant tree in dense, even-aged high forest and an isolated specimen, of the same age and on a similar site, in a park or garden. In the case of wattle, Craib's diagrams suggest that the crown of a mature tree should extend to one-third of its height. In discussing the application of the theory to intolerant conifers planted in the Union, he implies that, at 30 years of age on a good site, an average mature tree of *Pinus patula* should have a breast-height diameter of 28 inches, a height of 90 feet and a crown extending almost to two-thirds of its height. Whether the crown would actually extend so far down the stem with this species, or not, is immaterial. With many intolerant species it would certainly extend to one-half of the total height and, as Craib points out, " the first query which challenges the validity of these measures is the effect they will have on the quality of timber produced."

In replying to this question, Craib's first contention is that, with many species, some pruning would be essential, pointing out that it would be confined to the final crop trees and recognizing that, in conformity with the theory of absolute dominance, it must be limited to dead and drying branches and, in consequence, delayed until the trees had attained a considerable diameter. For instance, in the case of *Pinus patula*, referred to above, he considers that a pruning to 15 feet should be possible in the twelfth year, at an average diameter of 12 inches, and would be extended to 30 feet at a later date. In calculating the amount of clean timber to be expected from the outer 8 inches of radius in the first 30 feet of the mature tree, he has overlooked the fact that the pruning would have to be undertaken in two operations and, in view of this mistake, the figures he gives for lumber free from knots should be somewhat reduced. In fact, in the example quoted, it is doubtful whether the clean lumber, inclusive of sapwood, would exceed 50 per cent. of the volume of the final yield. This, however, would be a great improvement on the present state of affairs, in which there is " widespread prejudice against the utilization of locally-grown knotty timber."

The second criticism which Craib anticipates is that very fast-grown wood, even if free from knots, will be inferior in strength and quality to slower-grown timber,

whether artificially cultivated or derived from virgin forest. In general, his argument is "that if the utilization of wood and the profession of forestry are to maintain in the future the unassailable position they have held in the past, wood of the required kind must be produced cheaply. While it is common knowledge that modern wood-using industries are being constantly jeopardized by substitutes such as artificial wood, rubber, steel, cement, asbestos, etc., it must be remembered that wood is the universal substitute, and that for many purposes its only virtue is cheapness. It is presumably admitted, moreover, that to produce wood economically which will compete with the excessively slow-grown imported virgin timber is out of the question. Our objective must, therefore, be the production per acre of the largest possible volume of wood of requisite size, of the highest possible quality, in the shortest possible time, at the lowest possible cost." In particular, among several points quoted by Robertson, he contends that "different needs will have to be supplied by different species rather than by different growth rates." He might have added that fast grown timber on very short rotations is even-grained and, if free from knots, easily worked.

Provided that each species and each set of circumstances is considered on its merits, there is much force in these arguments. For instance, in 1918, in the working plan for the Nilambur teak plantations, S. India, it was laid down by the writer, and widely accepted in Burma, that, for maximum volume production, particularly on good quality sites, future teak plantations should be thinned to secure even espacement of vigorous dominant trees *before competition became serious*, and that the process of thinning should be more or less completed before the end of the period of principal height growth. On the other hand, such heavy thinnings were recognized as inapplicable to plantations in which domination and suppression had already occurred. These are comparable to Craib's prescriptions for the treatment of wattle and plantations of intolerant eucalypts and conifers, as applied to an important broad-leaved timber tree, intolerant of crown competition and very fast-growing in early youth, of which the local value of the final crop was out of all proportion to the value of the thinnings. Moreover, in spite of the fact that the woodworking properties of fast-grown plantation teak are greatly inferior to those of slower and more evenly grown natural teak, the early thinnings, which aimed at the removal of seven-eighths of the original crop, could have been justified on financial grounds even had they been unsaleable. Indeed, ample evidence has accumulated, in recent decades, from research in many countries, that, with relatively fast-growning species, either wide espacements in planting or early and heavy thinning, or both, result in the highest increment per tree and per acre and may with advantage be adopted in practice, provided other considerations, both silvicultural and economic, do not demand some modification of the policy of maximum volume production. Finally, in the circumstances prevailing in such areas as South Africa, where enormous quantities of softwood lumber are annually imported at considerable cost, Craib's arguments are of special significance, and the early production of inferior home-grown timber of several species may be more than justifiable.

So far, Craib's theories should meet with wide approval, but, in generalizing with regard to European and American silviculture, he has laid himself open to criticism.

It is not implied that some of his criticisms of traditional theories are unjustified, but he has ignored his own stipulation that his theories cannot be applied to even-aged crops in which domination and suppression have once occurred and is obviously unaware of much research which has thrown light on the inefficiency of stocking in dense regular woods of many species. Apparently it would surprise him to learn that a new philosophy of silviculture is being practised in many continental forests, whereby the efficiency of production is being greatly increased and, paradoxically, partial suppression of regeneration is sought as a means of producing slower and more even-grained timber in the mature tree, which, yet will compete technically and economically even with cheap virgin lumber. Nevertheless, the exposition of his theories is stimulating and should provide foresters in general with much food for thought.—R. BOURNE.

THE REVIEW AND SUMMARY

Is this another case of " Semper aliquid novi ex Africa " ? Have we here a new outlook on silviculture, a new conception of silvicultural principles which should profoundly affect practice not only in wattle plantations for bark, not only in plantations of fast-growing trees for timber in the Tropics or Sub-Tropics, but also in plantations or natural forests of conifers in all countries, and which incidentally will make forestry profitable and, therefore, practicable under many circumstances where this is not the case at present ? The reviewer would like at once to state emphatically his opinion that there is a prima facie case for this claim, in the hope that he will at least help to induce all silviculturists to study Craib's disquisition most carefully, and not to pass it by as being applicable only to antipodean monstrosities in the tree world such as wattles and eucalypts. Craib's new silviculture is calculated to establish forestal conditions and preserve the factors of locality at least as efficiently as silviculture on the present orthodox lines does. Moreover, he gives strong indications that his methods will produce a far higher mean annual increment of the forester's ideal—perfectly clean, knotless timber.

Craib's own claims or suggestions as to the possible general applicability of his principles may be quoted here. He points out that (owing to the rapid growth and short rotations) the wattle industry has given a field almost unique in forestry for studying silvicultural principles :

> " for it affords the investigator an opportunity of reaching finality in determining silvicultural cause and effect within a very limited number of years. In fact, so striking are the principles, particularly as regards thinning, which have recently been clearly defined in wattle silviculture, that one feels impelled to attempt an interpretation of all silviculture, however superficially, in the light of these results. While no attempt will be made to define the varying degrees to which different species conform with the principles underlying thinning in wattle silviculture, one hopes to suggest, at least, that the same principles are involved."

In his discussion of his wattle results, he states :

> " This factor of absolute as opposed to relative vigour, studied in all its ramifications on all site qualities, forms the basis of the most important silvicultural principle which has emerged from the wattle research during the past five years,

It is of such importance that I am convinced it undermines completely, for wattle production at least, the whole basis of tree classification and thinning as understood by silviculturists for the past century or more."

In introducing his discussion of the application of the new principles to plantations of conifers in South Africa, Craib writes :

" It would be radical to suggest that the management aimed at in wattle production might be made to apply also to the coniferous species in which the Union is particularly interested. Yet observations made in the coniferous plantations of Natal, and more recently in large plantations in the North-Eastern Transvaal, are so striking that an attempt will be made to show, in the light of recent wattle research, that we are running the risk of failing to achieve our main objective."

Finally, after briefly and tentatively indicating that the same principles may hold good also for the more slowly-growing conifers of Europe and America, he states :

" This philosophy of thinning, if sound, would appear to offer material improvement in the economic prospects of both national and private forestry. Much of it, however, has still to be corroborated by research " : and his conclusion is : " This paper does not suggest that a policy of universal heavy and early thinning should immediately be adopted. It is a sincere attempt to point out, in the light of results already achieved in wattle research, the pitfalls which may, and probably do, confront those who are responsible for the technical administration of pure 'even-aged stands.'

Actually Craib's arguments and demonstrations of his " philosophy " of thinning have been so convincing that within about a year from its first enunciation not only has it already been adopted widely in the wattle industry, but it can be said that many of the South African forest officers, of European as well as American schools of training, consider that it should be applied also in plantations of conifers and other species as well as in wattles and eucalypts.

The wattle investigations refer to *Acacia mollissima*, the predominant species in the Wattle Bark plantations of the Union, which are situated mainly in the zone with a mean annual rainfall of not less than 35 inches, and between altitudes of 1,500 and 4,500 feet, in the summer rainfall region, and in localities where frosts are not severe. *Acacia decurrens* has recently been adopted in some plantations, and is likely to take the place of *A. mollissima* in certain areas. Silviculturally the two species are similar. They are grown in pure even-aged stands, reaching heights of, say, 40 to 70 feet according to locality and treatment, though are capable of growing to 100 feet, with diameter of 24 inches, under ideal conditions. When the crop is reaped by stripping the bark and felling the trees, regeneration is usually effected naturally, abundant dormant seed being available in the soil. New plantations are usually established by sowing seed in lines in well-prepared ground, and in some cases this method is used in regeneration of existing stands.

Until Craib was detached for these investigations in 1928, the wattle industry had developed on its own lines with a large measure of success, the Forest Department refraining almost entirely from giving advice as to the silvicultural treatment

owing to lack of research or experimental data. A more or less standard practice had arisen of growing the trees in rows about 12 feet apart. In the case of areas under regeneration, a dense stock of seedlings, resulting from broadcast burning of the slash, covered the ground. After about a year and when the seedlings were about 1 to 4 feet high, they were spaced into the rows 12 feet apart and about 1 to 2 feet in the rows. They were afterwards (within about eighteen months) thinned to a final distance apart in the rows of about 3 to 6 feet. Subsequent thinning was the exception rather than the rule, though many of the trees in the rows became obviously overtopped and suppressed. A standard rotation of eight years was adopted on all sites.

Disadvantages of this system were fairly obvious to Craib, especially the checking of vigour and growth of the seedlings during the first year, due to the intense competition for the available moisture in dry periods, the thin whippy growth of the trees owing to the close spacing in the rows, and the dense growth of weeds and grasses in the wide space between the rows into which the roots of the wattles did not penetrate for several years. The advantage claimed for the wide space, that it allowed of cultivation by agricultural implements, was not realized in practice, for cultivation for several years was too expensive, and it would have continually injured the wattle roots. Yields of bark per acre were falling off. Craib writes :

> " An analysis of the growth under these conditions gives the reason why the eight-year rotation became so widely popular on all sites and under all conditions. By the eighth year growth stagnation was obvious even on the best sites, under a system of grossly inadequate thinning which maintained 750-900 trees per acre from the second or third year to finality. Intense mutual competition and suppression between the component individuals of the stand during the seedling, sapling and immature stages was the direct cause of an early culmination of both the current and mean annual increment curves; by the eighth year all stands were decadent, and a short rotation on all sites was therefore inevitable. Site quality frequently influenced the increment less than the degree of competition allowed during the first four years of the rotation."

His figures show that a typical yield was only 6·2 tons of green bark at 8 years, the current annual increment culminating at 2·0 tons at an age of 3 years, the mean annual increment culminating at 1·12 tons at 4 years and growth being practically nil after the sixth year.

Craib's first experiments consisted of some hundreds of permanent sample plots (distributed widely in different localities and site qualities), partly designed to determine statistically the effect of burning before regeneration, delayed spacing, grass, cultivation, artificial fertilisers, thinning, etc., but the main object was to test and demonstrate the advantage of ordinary silvicultural treatment, *viz.*: (*a*) rows comparatively close (6 feet), in order to secure an improved distribution of the growing stock and an improved selection of the trees to be left by the thinnings and to facilitate grass control ; (*b*) early initial spacing of the seedlings in the rows to exclude any factor of suppression during the first year ; (*c*) rigid control of grass, weeds, etc., and (*d*) continuous thinning designed to reduce the number of stems per acre gradually

throughout the rotation. Comparable adjoining plots, with the old wide spacing of 12 feet between the rows, were established for comparison, and in some of them improved treatment in the way of spacing and thinning in the rows was provided.

The summary of the results of these plots (with two Tables) deserve careful study. Briefly, results at first came well up to expectations. The early spacing out of the seedlings resulted in height growth being considerably increased—in some cases as much as ten times.

> " The improved vigour of the seedlings has led to a marked increase in the rate and degree to which they can respond to subsequent thinning."
>
> " The release of soil moisture normally absorbed by competing vegetation has stimulated the rate of growth in the stand as a whole. In some cases this one factor alone has contributed to a trebling of the bark (and wood) production by the third year."
>
> *But* " While the close initial espacement (6 foot rows) did lead to an early closing of the canopy, efficient and cheap grass control and a high degree of initial selection, the results by the third year were the reverse of what was expected. Although the stripping of many 2-3 inch trees on the close espacement yielded twice as much immature bark as did the stripping of fewer trees on the wide espacement (12 foot rows), the average tree comprising the stand in the third year (when the number of trees per acre was the same) was perceptibly poorer than on the wide espacement. The initial advantages secured by the close espacement were more than balanced by its subsequent disadvantages. There was, as early as the third year, a marked drop in the trend of the current annual increment curve in the trees on the close espacement as opposed to the wide. "

The tables show that at the age of 3 years the average height of the 600 trees remaining in the " well-managed close initial espacement " stands was 30 feet, whereas that of the 600 trees remaining in the " well-managed wide initial espacement " stands was 35 feet ; and that in the former the current annual increment culminated in the third year at 2·0 tons, falling to 1·2 tons in the fourth year, whereas in the latter it continued to increase up to 2·3 tons in the fourth year.

In each case, the trees at 3-4 years were what would normally be described as uniform, well-spaced, *dominant* trees, but actually those of the stands with wide rows were much more vigorous and 5 feet taller than those of the stands with closer early espacement. On the basis of subsequent work, all these apparently dominant trees were found to be actually to a greater or less extent suppressed.

Craib here develops his principles of *absolute* dominance and vigour as expressed by the amount of foliage, as well as size, of the crowns (which he found to correspond closely with root development), and his study of this subject resulted in the preparation of a chart illustrating the crowns of young, middle-aged and mature trees divided in each case into ten grades of vigour. The crowns of full or No. 10 vigour have ample crowns (of dense foliage) down to the ground in the case of the young trees (about 20 feet high), of half the total height in the case of the middle-aged trees (about 45 feet high) and of one-third of the total height in the case of the mature trees (about 70 feet high). In each case three degrees of density of foliage are included in the classification —*e.g.*, a young tree of full crown, but with light foliage is classified as of 6 grade.

The heights mentioned are only given as a rough indication of the sizes of the trees in the three age-classes. Craib writes:

> " Height is excluded as an indication of vigour in a stand, because it has no meaning unless correlated with an accurate knowledge of age, site, quality *and treatment*."
>
> " This chart has already proved itself to be a sound basis for tree classifications and thinning of wattle silviculture. There is a close correlation in current bark (and wood) increment between trees of the same age but differing in crown class. The current growth of a 10 tree is approximately ten times that of a 1 tree. The fundamental point of difference, however, is the fact that a 10 tree, with adequate thinning, will maintain its increment and delay its period of culmination, whereas a 1 tree will not. Stands exhibiting poor crowns invariably and irrespective of subsequent management, have early volume culmination, and demand shortened rotations."
>
> " The investigation and results which made the formulation of a revised basis for tree classification and thinning necessary, the chart itself, and its implications regarding future management, all point to a re-orientation of silvicultural practice as applied to wattles. We now know that the growth in all existing stands in the industry is curtailed beyond hope of absolute recovery through suppression. Stands and sample plots showing the best growth at 5 to 7 years of age can be graded no higher than 4, while the best stands or plots at 2 years are only 6. The vast majority of the area in the wattle industry is composed of trees with an average vigour of 1 to 3, almost irrespective of age."
>
> " It has taken a considerable time to appreciate the extent to which the increment in wattle production is dependent upon crown vigour, and the sensitiveness of crown vigour to thinning. During even short periods of overcrowding there is an immediate and rapid reduction in crown volume and density, and a corresponding fall in the growth rate. There is, moreover, no absolute response once competition is relieved by thinning, as can be demonstrated in almost any wattle plantation. The current increment bears a direct relation to the crown vigour after the period of suppression. Future growth, irrespective of thinning, continues at that rate until the next period of suppression, when it is again curtailed. In other words, even though there is an increase in crown volume, height and diameter, the trees, in relation to an absolute standard, remain in the same class as before. Because of this lack of response of suppressed trees to thinning, it has become increasingly clear that the management of a wattle plantation must be governed not by the optimum conditions of any site, but by the short critical periods to which that site will sooner or later be subjected. The rapid height, volume and diameter increment in wattles, particularly during the early stages, results in comparatively well-thinned stands becoming grossly overstocked within a few months. The consequent reduction in crown vigour is a permanent factor, and can in no way be increased. "

It became evident that to secure the maximum production, it is necessary to ensure as far as possible that the trees in a stand should be of maximum vigour (on

the basis of the chart), and that for this it is essential to space out the seedlings more widely in the first year and to carry out heavy and frequent thinnings in the first few years.

> " Thinning must anticipate suppression and must not be delayed until the trees need relief." " The major thinning operations must be completed prior to the culmination of the height growth, namely, the third year . . . . Thinning must deliberately reduce production during the first three years, in order to improve the quality of tree upon which subsequent production depends."

Some indication of the results as regards increased height growth which could be expected from this revised treatment is given in a table, which may be condensed thus:

Age.	Stand table recommended 1929.		Stand table recommended 1933.		Present experimental stand table.*	
	No. of stems per acre.	Height.	No. of stems per acre.	Height.	No. of stems per acre.	Height.
6 months ..	3000	3 ft.—5 ft.	750	3 ft.—5 ft.	500	3 ft.—5 ft.
1 year ..	2000	9 ft.	450	12 ft.	250	14 ft.
2 years ..	1400	20 ft.	300	25 ft.	170	28 ft.
3 years ..	600	30 ft.	200	38 ft.	170	40 ft.
	Thinning to continue.		Thinning to continue if necessary.		Thinning to continue if necessary.	

The increase in diameter growth will be even more marked than that in height growth, and the mean annual volume increment will be considerably greater under the new treatment. Even in a 5-year old well, but not drastically, thinned stand with crown vigour of 5 grade, the mean annual increment was found to be 2 tons of green bark per acre, whereas 1 ton per acre was regarded as a very good increment under the Wattle-Growers' old system of treatment. It is extremely difficult in practice to produce a stand of trees approaching grade 10, but even if an average of, say, grade 6 or 7, could be obtained the improved yields would be very great.

In the course of this discussion of wattle silviculture, Craib refers to various tenets of orthodox silviculture, and suggests, at least, that they are unsound. Whereas orthodox silvicultural theory is based mainly on competition for light, he emphasizes the importance of the competition for soil moisture, and he regards this as the basis for interpretation of his results. He asserts that the usual system of classification of the trees in a stand and of degrees of thinning have no application in wattle culture ; in fact, it was " the direct cause of misinterpretation and delay in arriving at a sound conception of cause and effect in wattle silviculture as it is now understood." All stands of wattle, properly treated to maintain the vigour of the crop, should always be composed of only one tree class, namely, Dominant (or Predominant), for thinning

* *Vide* " Points on Wattle Production," by I. J. Craib, M.F., Ph.D., 1934. Union of S.A. For. Dept. Bull., No. 28.

should always anticipate suppression. Including this, a list of five reasons for the failure of the orthodox system is set out, and it is added:

> " It is now contended that the only suitable basis for thinning in wattle silviculture is an absolute one. This will be determined by a varying number of trees per acre for different site qualities in relation to height and diameter growth."

Craib also points out that in the usual discussions of the life history of a stand and differentiation into tree classes and of thinnings, nothing at all is said as to the effect of different degrees of crowding on the vigour of the dominant trees of the stand. A wattle stand may consist entirely of trees which would ordinarily be described as dominant but which on Craib's standard, and in his terminology, are all "suppressed." In another passage he says, " the degree to which crowns are exposed to light gives no indication of their silvicultural well-being."

Again, Craib asserts:

> " All silvicultural literature stresses the need for the maintenance of full canopy in order to preserve the site factors. It would appear from a casual survey of the rate and intensity of the thinning here advocated, that this principle would, to some extent at least, be violated."

He proceeds to controvert this by data of counts of number of leaves of fifty comparable trees separated according to his ten grades of vigour, showing that for the particular age class selected the number progressed from 1,100 for 1 grade trees up to 23,000 for 10 grade trees, and he adds:

> " As the leaves of vigorous trees are consistently larger (sometimes twice as large) than those of suppressed trees, these differences are more significant than the table suggests. While the ratio between these figures can be regarded only as approximate for all age classes, both statistical and ocular analyses support the contention that relatively few vigorous trees per acre, produced gradually by heavy thinning, cause more intense forest atmosphere, control grass, and preserve the site factors better than relatively many suppressed trees per acre of the same age. Light rather than dense canopies are associated with overstocked stands.
>
> " A relatively large gap made by thinning in the canopy of vigorous trees is temporary. On the other hand, a relatively small gap made in the canopy of suppressed trees is apt to be permanent."

On the subject of " tolerance," Craib follows on the lines of Toumey's definition, but points out that this refers to reproduction under canopy or to underwoods, and so for application to pure, even-aged stands, he defines tolerance as " the capacity of the increment of a species for withstanding competition, and particularly its capacity for regaining normal increment after a period of curtailment through overstocking.

According to this definition, Wattle is an exceedingly intolerant species.

It is usually implied that there will be an effective response to thinning in densely-stocked stands, but Craib shows that when once the vigour of a wattle stand has been at all seriously impaired by too severe competition, the response to thinning is weak,

and full vigour is never recovered. He definitely recommends that thinnings should not be made in wattle stands when mutual suppression has gone beyond a certain stage.

It might be added that Wattle is, at the same time, extraordinarily tenacious of life (because it is a remarkably drought resistant, as well as an extremely moisture-loving tree), and even trees which are suppressed in the ordinary sense of being completely overtopped) in a congested stand will survive indefinitely, thus helping to bring about complete congestion and stagnation of growth. Wattle might thus in a sense be described as a very shade-bearing tree, while also being certainly a strong light-loving tree.

Then again, Craib asserts:

(*a*) " There is no correlation between height growth and site quality regardless of thinning." Actually, the height growth on third quality sites in well-thinned stands is greater than that on first quality sites in poorly-thinned stands."

(*b*) " There is no correlation between site and the period of culmination of height growth, of the current annual volume increment, or of the mean annual volume increment, regardless of thinning. These vary within wide limits, and are dependent upon the management, particularly thinning."

(*c*) " Contrary to views expressed by Schlich (1925), Chapman (1931), Wolsey (1922), the Forestry Commission (1928), Gehrhardt (1921), and others the evidence in wattle research supports a postponed culmination of the mean volume increments on the better sites. Moreover, the more delayed the period of culmination (within limits) the greater the mean increment at finality."

In his conclusion to the first part of his paper, Craib points out that the theory of thinning he has elaborated differs from any of the schools of light or heavy thinning which have arisen in the past. He writes:

" The heavy degree and high rate of stem reduction per acre is restricted to the first third of the rotation. Thereafter it is both infrequent and light. Little thinning takes place during the latter half of the rotation. In many cases the objectives are radically different to those sought by widely accepted silvicultural theory. For instance, height growth is not accepted as an indication of site quality except under restricted circumstances; heavy branching (extremely difficult to obtain in practice) is regarded as the *sine qua non* of maximum bark and wood production; a low form factor (invariably correlated with trees of large crowns) is deliberately aimed at; the current and mean annual increments are deliberately reduced during the first third of the rotation so as to improve the vigour of the growing stock upon which the increment will depend during the latter and important half of the rotation; the accepted system of tree classification and thinning upon a relative basis is criticized and a new one upon an absolute basis is substituted; the culmination of the mean annual volume increment is postponed; the maintenance of dense canopy for the incidental preservation of the site factors is aimed at by means of heavy (within limits) thinning; the term ' tolerance ' is revised so as to have an immediate significance in the technical management of pure, even-aged stands."

and full vigour is never recovered. He definitely recommends that thinnings should not be made in wattle stands when mutual suppression has gone beyond a certain stage.

It might be added that Wattle is, at the same time, extraordinarily tenacious of life (because it is a remarkably drought resistant, as well as an extremely moisture-loving tree), and even trees which are suppressed in the ordinary sense of being completely overtopped) in a congested stand will survive indefinitely, thus helping to bring about complete congestion and stagnation of growth. Wattle might thus in a sense be described as a very shade-bearing tree, while also being certainly a strong light-loving tree.

Then again, Craib asserts:

(*a*) " There is no correlation between height growth and site quality regardless of thinning." Actually, the height growth on third quality sites in well-thinned stands is greater than that on first quality sites in poorly-thinned stands."

(*b*) " There is no correlation between site and the period of culmination of height growth, of the current annual volume increment, or of the mean annual volume increment, regardless of thinning. These vary within wide limits, and are dependent upon the management, particularly thinning."

(*c*) " Contrary to views expressed by Schlich (1925), Chapman (1931), Wolsey (1922), the Forestry Commission (1928), Gehrhardt (1921), and others the evidence in wattle research supports a postponed culmination of the mean volume increments on the better sites. Moreover, the more delayed the period of culmination (within limits) the greater the mean increment at finality."

In his conclusion to the first part of his paper, Craib points out that the theory of thinning he has elaborated differs from any of the schools of light or heavy thinning which have arisen in the past. He writes:

" The heavy degree and high rate of stem reduction per acre is restricted to the first third of the rotation. Thereafter it is both infrequent and light. Little thinning takes place during the latter half of the rotation. In many cases the objectives are radically different to those sought by widely accepted silvicultural theory. For instance, height growth is not accepted as an indication of site quality except under restricted circumstances; heavy branching (extremely difficult to obtain in practice) is regarded as the *sine qua non* of maximum bark and wood production; a low form factor (invariably correlated with trees of large crowns) is deliberately aimed at; the current and mean annual increments are deliberately reduced during the first third of the rotation so as to improve the vigour of the growing stock upon which the increment will depend during the latter and important half of the rotation; the accepted system of tree classification and thinning upon a relative basis is criticized and a new one upon an absolute basis is substituted; the culmination of the mean annual volume increment is postponed; the maintenance of dense canopy for the incidental preservation of the site factors is aimed at by means of heavy (within limits) thinning; the term 'tolerance' is revised so as to have an immediate significance in the technical management of pure, even-aged stands."

EUCALYPTS.

In a brief section on the Eucalypts, Craib does not present any data, but is undoubtedly right in pointing to the similarity of their growth to that of wattles, and to the fact that the intense competition in stands insufficiently thinned during youth leads to a poor type of dominant tree with restricted crowns which respond slowly, if at all, to later heavy thinning.

CONIFERS.

The last part of the article deals with Conifers, and is of the greatest interest and importance, both because it contains some strong evidence from Conifer stands of various ages up to maturity in support of the new philosophy of thinning, and because it indicates that this can be applied to Conifers, with the help of pruning, so as to produce the maximum volumes of clean timber on the shortest rotations.

A stand of *Pinus patula* planted 7 ft. × 7 ft. was in vigorous condition at the age of 4½ years, with mean height of about 26 feet. At 6 years, with height of 32 feet, the trees, including the dominants, had become of extremely poor vigour, their crowns being only a third, or less, of the total height, and increment borings showed that during the last two years diameter growth had fallen to about one quarter of what it was previously. The crowns were judged to be of only No. 3 grade.

A list is given of twenty other stands of this species, mostly planted 800 to 1200 per acre, and unthinned and 5 to 9 years old at the time of observation. In all stands of this description the crown vigour was judged to be only 2, 3 and 4 (in one case 5), and diameter increment had fallen off greatly after about the fourth year. An unthinned 10-year-old stand, 2000 stems per acre, showed extreme mutual suppression with crown vigour of only 1 grade, height of 40 feet and d.b.h. of 4·0 in. An 18-year-old stand, planted 1200 per acre, had crown vigour of only 2 grade (with height of 56 feet) and showed marked diameter reduction during the last ten years, though it had been thinned down to 400 stems per acre (no doubt during the latter period).

The list includes also a few other species, *e.g.*, a stand of *Pinus taeda*, 22 years old, with the number of stems reduced to 570 per acre from the original 2500, height of 50 feet and d.b.h. of 7·5 in. The grade of crown is only 2, and diameter increment has been reduced to thirteen annual rings to the inch. An 18-year-old stand of *Pinus montezuma*, with the number of stems reduced from 1200 to 250, height of 65 feet and d.b.h. 9·8 in. was relatively vigorous, with crown grade of five.

Continuing to discuss *P. patula*, Craib writes:

"Of the numerous compartments inspected a considerable degree of success was observed in only three cases:

"(*a*) At Jessievale patula was planted 12 ft. × 12 ft. and interplanted with *P. pinaster* 4 ft. × 4 ft. At 9 years of age the patula had suppressed all the pinaster and most of them were dead. The biggest patula at this age were 13 in. in diameter and 63 feet high. The pinaster has since been removed, but no thinning has taken place in the patula stand. To-day, ten years later, the average height is 65 feet, average d.b.h. approximately 10·5 in. and the average vigour of the crowns 5. This stand virtually started with 300 trees per acre, is

considerably superior to stands which theoretically have offered a vast improvement in selection. Increment borings show competition began to cause increment reduction in the tenth year, and that to-day it is less than half what it might have been (per tree) had a thinning then taken place. There is little doubt but that the initial increment per acre was low in this stand in relation to heavily stocked stands.

"(*b*) A stand of 4 ft. × 4 ft. patula at Graskop was thinned heavily in the seventh year and again in the eighth. In the ninth year the forester was told to remove all the wolf trees in the stand. Misunderstanding the term, he felled all the dominants and reduced the stand to 200 trees per acre. His thinning was rightly condemned by his superior officers.

" To-day, nine years later, this stand is probably the best stand of patula in the Union. Height 90 ft., d.b.h. 12 in., crown vigour 6. On the lower slopes of the same compartment the thinning was much lighter, namely, about 400 trees per acre, and the trees are much smaller (cause or effect ?).

" A stand of lightly-thinned patula adjacent to the stand containing 200 trees per acre, at eleven years, carries 1500 trees with a d.b.h. of 4 in. and an average total height of about 35 feet. The disparity is obvious.

"(*c*) A stand of patula on the Waterval Estates as started with an initial espacement of 8 ft. × 8 ft. At six years it was thinned down to 400 trees per acre. The stand is now ten years old and the crown vigour of 6 and the diameter growth are markedly higher than those of average stands of the same age initiated at a closer espacement and thinned more lightly."

Craib also refers to the article by J. J. Kotzé (1926) on *P. patula*, saying that, though the permanent sample plots have been thinned more heavily on the whole than average stands of the same age, it is evident that the results show only a slight improvement, thinnings not having been commenced before the ninth year in most cases.

In discussing the data on *Pinus pinaster* by Zahn and Neethling (1929), Craib criticizes the thinning upon which their yield tables are based. Some indication of increment obtainable under the new silviculture is given in figures of a stand of this species at Newlands quoted from the same article. It is understood that the stand was self-sown and had no silvicultural treatment. Probably it was so irregular in youth that there was no severe competition among the dominants. The final crop at the age of 51 years consisted of 102 stems per acre, with average height of 110 feet, average d.b.h. of 20·8 in., and volume of 11,133 cu. ft. (over bark). It must be noted that this is in an exceptionally favourable locality.

Another striking example of large production resulting from wide espacement in youth is given. *Pinus insignis* was planted about 1884 in several compartments at Tokai at espacement of 10 ft. × 20 ft., or 217 trees per acre. When clear-felled at about 34 years, the mean d.b.h. in the compartments ranged from 17 to 23 in., and heights from 120 to 140 feet, and the average yield was about 6000 cu. ft. per acre. The only thinning and pruning had been carried out only three years previously.

After some further observations on the reduced crowns and diminished annual diameter increment in stands with more or less close espacement and light or moderate

thinning, Craib suggests that all the important conifers in the Union are "intolerant" species, *i.e.*, species which lose their crowns when subjected to severe competition in close stands, and do not recover full vigour after such stands are thinned. He proceeds to reiterate for Conifers the principles of early heavy thinning already discussed for wattles, suggesting such radical prescriptions as:

"Practically all thinning will be completed by half the rotation age," and

"Thinning must foster as many branches per tree as possible. (This in practice will not be easy.)"

As regards the numbers of trees per acre with a view to securing full vigour, Craib writes:

"No attempt is made to define the age or the degree to which different species must be thinned on various initial espacements so long as the need for thinning coniferous stands down to 300 to 400 trees per acre at an early age is stressed. It appears that thinning must, moreover, be more or less completed by the fifteenth to twentieth year for almost all species."

In the case of *Pinus patula*, Craib indicates that with, say, 4 ft. × 4 ft. planting, the first thinning should be done in the second year, and that it can only be postponed to the sixth year if the initial espacement is not less than 9 ft. × 9 ft.

It is pointed out that, while it is less necessary to apply these principles to "tolerant" species, it is equally desirable to do so in order to secure maximum production without loss of time. Also it is emphasized that it is even more desirable to apply them on sites of average or poor quality than on good sites, for on the former the dimensions required for timber will not be attained by present methods except on very long rotation, if at all. It is pointed out also that the final number of trees per acre is not affected by these recommendations, that the total number of stems removed in thinning is the same, but it is a question of the stage at which they are removed.

Craib lists, and combats, nine silvicultural principles which have been opposed to such heavy early thinnings. Apparently these principles still hold the field in the practice of Silviculture in Europe, and Craib at least throws out the suggestion that they should be revised and that his new principles of thinning might apply there also. He writes:

"Under the conditions of slow growth which prevail in Europe and the consequent long rotations, it is possible that the principles here discussed were thought either to have no application at all, or to be of little importance. Despite this, however, publications of standard yield tables for European species show marked increment reduction through suppression if interpreted according to the standards here set forth. For example, the British Forestry Commission, Weise (Southern Germany), Schwappach (Prussia), Gehrhardt (Germany), Maass (Sweden), Ilvessalo (South Poland), and Filitschkin (Russia) (*vide* Bull, 10, British Forestry Commission), all agree that Scots pine, a species which is admittedly highly intolerant, should be grown with 810 to 1350 trees per acre for 30 years on a first quality site. On a fifth quality site the same species is made to carry from 1740 to 3160 trees per acre for 40 years. The excessively low volume yields and small diameters in 100

years which result from this practice they ascribe to the limitations of the species and the site, and not to that of the management. Norway Spruce, a fairly tolerant species, different authorities grow at a rate of 1700 to 8345 stems for 20 years on site qualities comparable with the above. As before, final yields at 100 years are excessively low. There is, moreover, little foundation for the argument that stands are deliberately kept dense in order to increase the quality of the timber, for invariably thinning on the better sites is less light than on the poorer. This analysis applies similarly to American literature on the subject. While it is not suggested that site and climatic factors in Europe and America are identical with those that govern the rate of growth in the Union, there is, nevertheless, a striking similarity in the degree to which undue crown reduction has occurred under comparable systems of silvicultural management."

It remains to mention briefly Craib's discussion of the total volume and volumes of clean timber available under his treatment compared with those under ordinary treatment. He sets out two yield tables for *P. patula* in a first class locality, the one giving the present data, with estimated future figures for an existing sample plot, and the other giving estimated figures for his proposed treatment. In each case there are 130 final crop trees at the age of 30 years, but in the former their d.b.h. averages 18·0 in. and their volume is 6,500 cu.ft., while in the latter their mean d.b.h. is 28 in. and their volume is 14,950 cu.ft. Including thinnings, the total yields are 12,608 cu.ft. and 19,540 cu.ft. (under bark) respectively, and of these totals the calculated volume of knotless timber under the assumed treatment as regards pruning are respectively 5,909 and 9,272 cu. ft. The assumption as regards pruning in the latter stand is that 170 trees per acre would be pruned to a height of 15 feet when the d.b.h. is 12 in. at the age of 12 years and for a further height of 15 feet a few years later. Still better results would be obtained by starting pruning rather earlier and doing it in three stages. In the case of the ordinary stand, it is assumed that the first pruning is done when the d.b.h. is 6 in.

In connection with the high figure for clean timber in the example given, the first 30 feet (the pruned portion) contains 60 to 70 per cent. of its total volume. Of the volume of this lower length with d.b.h. of 28 in., the knotty core of 12 in. diameter at the base forms only a small proportion.

The final point discussed in the article is the question of the strength of the timber owing to the wide rings, and Craib writes:

" In this connection the following arguments may be introduced:

"(1) In artificial stands there is no available evidence which tends to show that rapidly-grown timber of a particular species is discriminated against for ordinary purposes, in relation to slower-grown timber of the same species. The major portion of the highest quality second growth taeda in the Southern States is obtained from rapidly-grown individual trees of large size and not from the smaller trees of the same age grown in dense stands.

"(2) The high density of slow-grown wood, *e.g.*, pinaster and canariensis, is a material disadvantage in relation to the higher cost of transportation.

"(3) There is no evidence that the strength of a weak wood, such as patula, can be increased to any extent by curtailing the growth rate. It is unlikely that it will

be possible to change the category into which the wood of a species falls by varying its rate of growth. Different needs will have to be supplied by different species rather than by different growth rates.

"(4) In relation to cost of production fast-grown wood will be considerably cheaper and better in quality (clearness) than slow-grown wood. This factor is, in itself, of great weight."

This very full summary has been prepared and is offered to the EMPIRE FORESTRY JOURNAL in the hope that Craib's silvicultural theories will thus reach many Empire foresters who might not see the original article or be able to appreciate their significance from a short review. Space does not permit of comment except to suggest one or two additional reasons why their adoption should be earnestly considered. They are calculated to ensure the maximum vigour in the trees comprising a stand and therefore its maximum powers of resistance to disease and insect pests. It is believed that their application to the production of saw timber is sound for the reasons Craib suggests, but there is an increasing tendency for wood to be utilized in the form of plywood and boards of various composition made from wood pulp, and the new silviculture will supply the maximum quantities of highly suitable material for these purposes in the shortest time and at minimum cost. This obviously also applies to the production of the enormous quantities of timber utilized for such purposes as boxes, matches and paper-pulp.

Craib has had an exceptional opportunity in his wattle research to study the principles of silviculture over practically a whole rotation, and his conclusions with regard to wattle are undoubtedly sound. He has shown independence of thought and ability in indicating their application to other species, including conifers. It is suggested that this paper should receive the closest attention in forestry in both hemispheres.

C. C. R.

(*Empire Forestry Journal*, Vol. 13, No. 2, 1934.)

INDIAN FORESTER

MAY, 1936

EDITORIAL

SIMUL PLANTATIONS IN ASSAM

We would draw the attention of our readers to the article in the current issue on Simul Plantations in Assam by Mr. J. N. Das, the Divisional Forest Officer, Sadiya Division. It will be seen from this article that 25 to 40 trees per acre of an average girth of 4′ 6″ represent a fully-stocked forest for all practical purposes. The photos we publish also show that even with only this number to the acre the trees are distinctly over-crowded and in need of a further thinning if a crop of big trees is required. This article confirms the opinion expressed in our issue of August, 1934, that the claims of Indian Simul Cotton Plantations, Ltd., to be able to produce 1,000 6 ft. trees to the acre at a rotation of 10 years. were contrary to any recorded statistics of the growth of crops as opposed to individual trees. In that article we were unable to give statistics from Assam; now that they are available our readers can judge for themselves how many simul trees to the acre it is possible to grow.

A SHORT NOTE ON SIMUL PLANTATIONS IN ASSAM

By J. N. Das, D.F.O., Sadiya Division, Assam

The importance of simul plantations was felt in the Sadiya Frontier Tract even when it was not a regular Forest Division under a Forest Officer. Regular *taungya* plantation was started by the then Political Officer—late Mr. Dundas—in 1915, and it was continued till 1925. An area of over 3,000 acres was under such plantation.

Unfortunately it was all in the U. S. Forests and mostly along the banks of rivers Lohit, Brahmaputra, Dibang and Dihang. The inevitable result has been that a major portion of the plantation has been washed away, due to river bank cutting.

Owing to the increase in population, some of the areas have been cleared (in spite of the executive order of Political Officer not to fell simul trees) for permanent cultivation. Whatever is left now is of such a scattered nature that no protection can be given to it by including the same into any reserve or making any new reserve.

The Working Plan recommends that simul may only be tried in suitable places with *taungyas* (*vide* para. 257 of the Working Plan). It is, however, doubtful if the local people will ever do it again, as they are gradually realising the importance of permanent cultivation, and have already realised that planting of any forest species with their crop in their cultivation area makes their interest suffer in the long run. So, if in future, any simul plantation is made, it will have to be done departmentally.

Planting in the past was done at different spacings. Some in 12′ × 12′ lines, some in 26′ × 12′ lines or 26′ × 26′ lines. It has already been found that 12′ × 12′ spacing is not satisfactory. In order to ascertain the suitable spacing for future plantation, I was recently examining some of the old *jhums* where simul was grown and I give below the result of my observation.

As the old *jhums* were originally not in compact areas, and as some were subsequently cleared either for making houses or for permanent cultivation, it was difficult to find even a block of one acre without gap. Most of the areas contain too many trees in places, while there are one or two trees wanting here and there.

It will be seen from the figures on the next page that in plots Nos. 1, 3 and 5 which were taken in three different places, *i.e.*, 1 and 3 on the south bank and some 40 miles apart, and 5 on the north bank, give 26, 28 and 29 trees per acre. These are more or less the normal areas, while the other two plots are too much congested in places. Some of the smaller trees apparently came up afterwards and formed an understory in some places. The age of the plants of all these plots is about 15 to 16 years and the average girth is 4′ to 4′-6″. The Working Plan Officer also came to the same conclusion from the figures he collected that the average age of a simul tree of 4′-6″ girth is 14 years (*vide* paras. 121 and 122 of Working Plan).

SIMUL WITH *taungyas* BY THE MIRIS IN SADIYA IN 1920 AND 1921

The following figures were obtained from the measurement of different plots—

Tree No.	Plot No. 1. 1 acre.	Plot No. 2. ½ acre.	Plot No. 3. 1 acre.	Plot No. 4. 1 acre.	Plot No. 5. 1 acre.
1 ..	3′—6″	6′—0″	5′—7″	5′—1″	5′—3″
2 ..	4′—9″	5′—7″	3′—0″	3′—9″	2′—1″
3 ..	5′—6″	7′—0″	5′—8″	4′—10″	4′—11″
4 ..	6′—0″	3′—3″	6′—7″	1′—9″	3′—1″
5 ..	6′—6″	6′—3″	6′—0″	2′—7″	2′—4″
6 ..	5′—6″	5′—7″	2′—1″	5′—1″	5′—2″
7 ..	6′—0″	2′—8″	3′—10″	3′—7″	5′—7″
8 ..	6′—6″	2′—0″	3′—10″	2′—1″	4′—1″
9 ..	6′—6″	5′—10″	5′—8″	3′—0″	3′—0″
10 ..	5′—0″	5′—6″	5′—5″	2′—8″	4′—3″
11 ..	6′—6″	4′—5″	7′—4″*	3′—7″	2′—5″
12 ..	4′—9″	4′—5″	3′—10″	3′—2″	4′—3″
13 ..	6′—6″	3′—3″	2′—9″	1′—10″	4′—6″
14 ..	6′—0″	3′—10″	5′—10″	4′—9″	4′—11″
15 ..	5′—9″	3′—2″	9′—9″*	4′—4″	5′—0″
16 ..	7′—0″	2′—7″	6′—6″	2′—10″	3′—5″
17 ..	5′—4″	6′—9″	11′—0″**	2′—2″	5′—10″
18 ..	4′—6″	4′—8″	5′—9″	2′—11″	4′—1″
19 ..	4′—6″	3′—4″	5′—5″	4′—7″	5′—9″
20 ..	6′—0″	5′—8″	5′—4″	4′—1″	2′—5″
21 ..	5′—0″	5′—3″	4′—0″	2′—2″	3′—4″
22 ..	5′—1″	6′—8″	5′—7″	3′—8″	3′—1″
23 ..	6′—0″	3′—4″	6′—11″	3′—6″	4′—11″
24 ..	4′—10″	5′—7″	4′—5″	3′—8″	4′—4″
25 ..	5′—3″	6′—0″	2′—7″	4′—3″	5′—7″
26 ..	4′—10″	..	5′—6″	3′—7″	3′—0″
27 ..	..	..	2′—2″	3′—3″	2′—8″
28 ..	..	..	1′—2″	2′—9″	7′—8″*
29 ..	..	..	..	3′—11″	4′—2″
30 ..	..	..	..	4′—2″	..
31 ..	..	..	..	3′—0″	..
32 ..	..	..	..	2′—4″	..
33 ..	..	..	..	5′—1″	..
34 ..	..	..	..	5′—0″	..
35 ..	..	..	..	3′—6″	..
36 ..	..	..	..	5′—2″	..
37 ..	..	..	..	5′—8″	..
38 ..	..	..	..	4′—9″	..
39 ..	..	..	..	5′—5″	..
40 ..	..	..	..	5′—8″	..
41 ..	..	..	..	4′—8″	..
42 ..	..	..	..	5′—7″	..
43 ..	..	..	..	4′—9″	..
44 ..	..	..	..	5′—4″	..
45 ..	..	..	..	3′—4″	..
46 ..	..	..	..	3′—9″	..
47 ..	..	..	..	4′—9″	..
48 ..	..	..	..	4′—2″	..
Average ..	5′—6″	4′—9″	5′—2″	3′—10″	4′—2″

*Is reported by the villagers to have been in the area when the plantation was created.

**Flat and forked beyond 5′ owing to two trees having joined together from the beginning.

Excluding the wolf trees, the normal girth limit of a simul plantation of 15 years age may be taken to be 4′-6″, while it may reach a normal girth of 6′ in 20 years time. If the exploitable size is fixed to be 6′ in future for the supply of saw mills and match factories, which can take trees from 3′ upwards, the rotation can safely be fixed to be not more than 25 years.

As regards spacing, I prefer 22′ × 22′, as it is easy to calculate acreage, and as it has been observed that the reasonable distance between two simul trees of 6′ girth should be 40′ to 50′. In the case of a plantation 22′ × 22′, the distance between the final trees will be 44′ × 44′, while the intermediate crop of about 3′ girth can go under thinning and can also be utilised. This spacing will give about 22 trees (final) per acre, and to me this seems to be an ideal figure, which should never exceed. My sample plots where I found 26, 28 or 29 trees are such that there is not much room for further addition of trees, except in some gaps.

I took some photographs of some of those plots. It will be seen from them that a simul forest containing 25 to 40 trees per acre of trees of average girth of 4′-6″ is fully stocked for all practical purposes.

THE PROBLEM OF NATURAL REGENERATION OF SILVER FIR (*ABIES SPECTABILIS*).

BY I. D. MAHENDRU.

Review of Past Work

The absence of natural reproduction in the fir forests has been recognised as a problem of outstanding silvicultural interest for at least the last forty years. In Kulu observations concerning the lack of natural seedlings were originally recorded in 1897 when the first working plan was prepared. Although the revised working plan prescribed shelterwood fellings in the fir forest, little progress appears to have been made with natural regeneration. Consequently a deplorable failure of regeneration in typical fir forests during the past quarter of a century was reported in the Forest Conference which met at Lahore in 1922.

SILVER FIR FOREST. TIKRU COMPTT. 16 (a). ELEVATION 9,500 FT. KILBA RANGE, UPPER BASHAHR DIVISION, PUNJAB

Photo : H. M. Glover.

Important discussions have, however, appeared in the tour notes written by various Inspecting Officers, and in other papers presented at subsequent Forest Conferences. These have contributed to a very appreciable extent to our understanding of the refractory behaviour of natural regeneration.

A brief mention will be made here of only such references which are of interest in their discussion of causes bearing on natural regeneration.

Trevor (1917) held as the chief causes of absence of satisfactory fir reproduction, excessive humus, grazing and insufficient light. He (1931) believed in the possibility of successfully regenerating fir forests of Manalgahr, Kangni and Shanag Shil in the Kulu Division, if shelterwood fellings combined with subsequent "ordinary routine of regeneration" were properly carried out. Later he prescribed (1931) one crown width as the correct spacing limit of seed bearers in the seeding fellings.

Parker (1932) considered the hope of regenerating fir forests with heavy undergrowth by the uniform system as too optimistic. He drew attention to the absence of regeneration under mother trees fully one crown width apart in the mature forests where such spacement was commonly met with. He suggested group system of management as highly promising.

Glover (1930) favoured experimental fellings in vertical strips in overmature fir forests with no regeneration present which should be confined to ground of moderate slope only. He was opposed to extensive shelterwood fellings on grounds of difficulty and expense in obtaining a clean seed bed; to clear cuttings on a large scale, on account of the danger of erosion and reduction in the fertility of soil; to strip fellings against the sun, on account of difficulties of extraction and management. He (1935) does not admit that there is a general shortage of fir regeneration in the Eastern Circle. He favours selection fellings combined, where necessary, with vertical strips, to be planted up artificially, and is not prepared to say at present and until further experience has

been gained by experiment that vertical strip fellings will prove a success as regards *natural* regeneration.

Parnell (1930) observed that seedlings of silver fir did not stand the amount of light afforded by a heavy seeding felling.

Flewett (1930) attributed failure to browsing, and considered light opening of canopy combined with shelter from afternoon sun and exposure of mineral soil as favourable factors.

Pring (1930) was of the opinion that exposure of seedlings to sun under shelterwood fellings was an inimical factor on account of alternate drying and wetting of humus. On the other hand, gradual opening of the canopy induced natural regeneration, owing to the maintenance of moisture in the soil. He (1932) also pointed out the injurious effects of thick matting of organic matter consisting of weeds pressed down and compacted under the weight of snow.

Deans observed that in large gaps, regeneration was conspicuous by its absence, and where the humus was 2″-3″ thick, soil conditions were most favourable for the establishment of regeneration.

Methods of Investigation

Experimental work concerning fir was concentrated in the Kulu Division, in the research nurseries at Manali as well as in experimental plots laid out in the fir forests.

The factors under investigation were :

(*a*) *Light requirements*—

Differences in the light climate (*i.e.* micro-climate) under,

(*i*) varying degrees of brightness of seeding fellings ;

(*ii*) opening in canopy of different sizes under selection system ;

(*iii*) strip fellings of varying widths.

(*b*) *Temperature requirements*—

(*i*) changes in temperature climate (micro-climate) in relation to the development of seedlings and incidence of casualties ;

(*ii*) differences in the temperature climate due to different types of opening made under shelterwood, selection and strip fellings.

(*c*) *Water requirements*—

(*i*) Seasonal and periodic changes in the moisture climate (micro-climate).

(*ii*) Differences in the moisture climates (micro-climates) due to different kinds of fellings.

(*d*) *Edaphic factor*—

(*i*) Soil type as an œcological factor.

(*ii*) Physical and chemical properties of soil.

(*e*) *Undergrowth relationships*—

(*f*) *Factors responsible for œcological changes in the fir zone.*

Light Relationships.

The interpretation of the light requirements of fir seedlings has varied with different observers, and has followed a definite trend of thought. In the more remote past, there was marked tendency to ascribe the failure of regeneration to low intensity of light available in the mature fir forests. The application of shelterwood system was the logical outcome of this line of thought. More recently opinion has veered in the opposite direction, and the need for protection against direct light has been particularly emphasised. There is at present a concensus of opinion in favour of group, selection and strip fellings as providing the most suitable light conditions for inducing natural regeneration. Even for seeding fellings, a maximum spacement of single crown width is considered as most suitable.

Observations made in the Research Division indicate that silver fir is particularly adapted to the utilisation of predominantly oblique and diffused light. This appears also evident from the compact columnar habit of the tree, and the organisation of the leaf arrangements permitting a minimum of vertical light to penetrate the masses of leaves below. The absence of reproduction observed under large openings in the canopy, occurring naturally or made artificially by seeding fellings, even in the presence of sufficient soil moisture and other favourable factors is explained by the high proportion of vertical to oblique light, though light as heat is the factor really involved.*

* It is impossible to isolate the effect of light as light, from light as heat, both being the manifestations of the same energy.

The minimum light requirements of a species may be approximately assessed by measuring the light intensity in the darkest part of the tree where normal masses of leaves occur and function. Judged in this manner, it is evident that the minimum light requirements of fir are much lower than intensities which actually exist in the mature fir forests. In the case of fir seedlings the composition of light as regards the relative quantities of oblique and direct (overhead) light is of much greater significance for the development and well-being of seedlings than the total light requirements.

Silvicultural systems differ significantly in the light intensity under the openings in the canopy made by fellings. The superiority of illumination observed in the case of fir reproduction under selection and strip fellings is attributable to the peculiarities of exposure characterised by the relative predominance of oblique light. In the experimental plots of the Research Division, most satisfactory conditions of regeneration had been recorded under strip fellings, the strips running vertically down a slope facing N to N-E. The following statement summarises the actual results obtained—

Width of strip	Average number of seedlings per 100 square ft.
50 feet	9
75 ,,	6
100 ,,	4

It is seen that the 50′ strip has given better results than either the 75′ or 100′, and that the results are inversely proportional to the width of the strip.

The wider the strip, the more is its central portion exposed to the action of overhead (vertical) light which can find direct access to the ground; the observed greater number of seedlings close to the edges of the strip is explained, in large part, by the beneficial effect of the oblique exposure of the margins of the wooded stand producing favourable temperature conditions. Tentatively it appears that optimum light conditions are provided in a strip of 50′ width.

The optimum size of opening under the selection system is still under investigation.

SILVER FIR FOREST WITH SOME KHARSU OAK. ELEVATION 10,000 FT.
KULU DIVISION, PUNJAB

Photo: R. S. Troup.

The characteristic profile of natural seedlings establishing themselves in a gap from periphery inwards, and gradually filling in centripetally can, with justification, be attributed to the beneficial effect of the oblique light, which is often referred to as a shade effect. Where in spite of the presence of oblique light, regeneration is conspicuous by absence, the failure can usually be explained by the operation of some other inhibitory factor.

The exposure of the habitat of fir forests in the higher altitudinal zones in which they occur has been interpreted as an indication of the intensity of direct light (vertical) requirements. The fact, however, cannot be ignored that the light climate of this zone is considerably modified by a high degree of clouding. Moreover in this connection, the œcological history, succession, changes and development of habitat are of very great significance. Mr. Glover has pointed out that a large proportion of our fir forests have developed from the high level blue pine and broad-leaved forests, particularly *kharsu* oak and birch.

Manipulation of the canopy under any silvicultural system which promotes the penetration of overhead light at the expense of oblique exposure, *e.g.*, heavy seeding fellings, not only acts as an inimical factor directly inhibiting the natural reproduction of fir, but initiates succession and other profound œcological changes in the environment which render it unsuitable for a very long period. Such opening in canopy stimulates tall herbaceous plants (balsam, *Strobilanthes*, etc.), prostrate herbs and coarse and thick grasses, which before the admission of light had struggled near the verge of their light minimum. By their spreading habits these plants are able to exclude the more sensitive seedlings of fir from establishment. The long drawn transitional stage which follows finally comes to a close only gradually with the appearance in course of time of shrubs and broad-leaved trees restoring the vertical distribution.

Temperature Relationships.

Temperature in combination with moisture is a deciding factor in the survival of fir seedlings. Temperature climate by which is

meant here the air temperature at about 4′ above ground is affected by the soil temperature.

Soil temperature is of great significance to the seedlings as a factor influencing the development of root systems and their physiological activities. Unfortunately data concerning the soil temperature are not available.

Soil temperature depends primarily on the degree of insolation, but vegetation, specific heat, structure and water contents of soil are important secondary factors. For a given locality, soil temperature exhibits a trend which is somewhat symmetrical with that of air temperature, though the maxima and minima are considerably modified.

The figures for temperature of the surface soil for the Manali nurseries have been calculated by adding 10 degrees to the air temperature data.

The following statement gives the relation between the maximum soil temperature and casualties among fir seedlings—

Maximum soil temperature	Casualties	Month and fortnight
102	.. 10%	.. 1st fortnight May
106	.. 17%	.. 2nd ,, May
108	.. 54%	.. 1st ,, June
104	.. 34%	.. 2nd ,, June

It is evident that although the lethal limit of growth of fir seedlings was not reached, soil temperatures above 100 degrees were very injurious.

Soil temperature is one of the factors which is changed when the canopy is manipulated. On account of differences in the degree of insolation, as expressed by the intensity of light admitted, soil temperature climate differs under opening in the canopy made by shelterwood selection and strip fellings. Quantitative data concerning the differences in temperature involved are not available.

Under seeding fellings, vertical light which penetrates the soil rapidly warms it up in the spring. This has the effect of arresting the development of root system, as the upper layer of humus dries out quickly and soil moisture becomes the limiting factor. This explains

the development of shallow root system of fir seedlings, and high incidence of casualties reported by various observers under heavy seeding fellings. In the case of the strip and selection fellings, the warming up of soil due to the preponderance of oblique light is relatively a slow process, which accounts for the better development of seedling roots and higher survival percentage. In the research nurseries at Manali which is very low for fir, and below its natural habitat, seedlings which grow in the open often suffer from heat lesions on seedling stems at the point where they emerge from the ground.

The lower temperature limit of life for fir seedlings was not recorded at Manali, but temperatures at which freezing of seedlings occurs are known to be frequent in forest conditions. Fir seedlings are believed to be susceptible to frost, and casualties from its effects are reported by various observers.

Transpiration-evaporation Relationships.

Moisture conditions of the soil surface are of great importance in relation to the germination of fir seed and the early growth of fir seedlings.

Saturation deficit of the air together with the temperature determines the physical transpiration rate. Transpiration as a purely physical effect can be determined by means of atmometer. Although the instrumental values do not correspond exactly to actual transpiration, there is close parallelism, and the results interpreted with caution are still very useful.

The degree of wetness or dryness of soil surface during any defined period is determined by the precipitation; soil type and its vegetation covering are important secondary factors. The efficiency of precipitation depends upon its distribution, run-off and percolation through the ground. When evaporation exceeds precipitation dry conditions result.

Evaporation data are not available. Such data, even if available, are difficult to apply owing to the complexity and variability of a number of factors.

It has, therefore, been considered advisable to use a simple formula to express the intensity of aridity, known as de Martonne's index, $\frac{P}{T+10}$, P being the summation of daily precipitation, and T that of daily temperature, during a given period.

The following statement shows the relationship between the aridity index and the casualties among the fir seedlings in the Manali nurseries—

Monthly index of aridity		Percentage casualties
·54	..	7
April ·50	..	6
May ·04	..	17
June ·10	..	50

Thus evaporation rises during April-June to a limit of dryness in a habitat which otherwise exhibits a hygrophytic climate. Fir seedlings are hygrophilous, and casualties occur when the factor touches about ·50 index value indicating conditions of negative water balance in the economy of plants.

In so far as temperature and evaporation climates exhibit a close parallelism, openings in the canopy made under different systems show significant differences. Investigations in this respect are likely to prove highly useful.

In the altitudinal zone in which fir forests are situated, the air and surface soil are more humid than at Manali owing to decrease in evaporation.

Soil Type Relationships.

The failure of regeneration of silver fir has been attributed by various observers to unfavourable soil conditions. These are characteristic of the type of soil on which the fir forests occur. Investigations carried out in Kulu show that fir soils belong to the group of podsols though they differ from the well-known typical podsols in certain important respects. As results are being presented in a separate publication, only a brief allusion to them will be made here.

Podsols may be defined as damp and "degraded" soils developed under moist conditions prevailing in the mature fir forests due to a low

level of evaporation in relation to precipitation. Characteristic of these soils is their definite stratification, with the thick humus layer over-lying the mineral soil. The upper layers of mineral soil are markedly leached out on account of the removal of soluble material inclusive of iron and phosphoric acid by the absorptive action of "unsaturated" humus material. Soils so impoverished become considerably reduced in weight in the course of time.

The dissolved substances are under certain conditions redeposited in the layers of soil below, leading to the formation of hard "pan" in which precipitated colloids bind the soil particles together.

The more useful salts and alkalies are precipitated to a much smaller degree than the less important compounds of iron and aluminium, and so are lost to the plants. Moreover, material accumulated in the pan are not at the disposal of the plant roots.

The œcological properties of podsols in relation to the development of fir seedlings may, therefore, be summarised as under :

1. *The accumulation of a thick layer of acid humus.*—This is due to the slow decomposition of humus on account of the cold climate of fir forests. The remains of vegetation, needles, etc., are only gradually incorporated into the soil, and so the humus consists of a half decayed mass in which the structure of organic remains can still be distinguished.

The thick layer of humus is made more impervious with the wefts of moss, and fungal mycelia.

This matted mass of humus prevents purely mechanically the penetration of roots of fir seedlings.

Moreover, on account of surface evaporation, the upper layers are rapidly dried out. Although the moisture contents of "dry" humus remain at a fairly high level, the moisture thus retained is not at the disposal of seedling roots on account of the high water-holding capacity of humus. This explains the heavy casualties among fir seedings in April and May soon after germination.

Finally, the impervious layer of humus prevents evaporation of water from below, leading to boggy conditions and bad soil

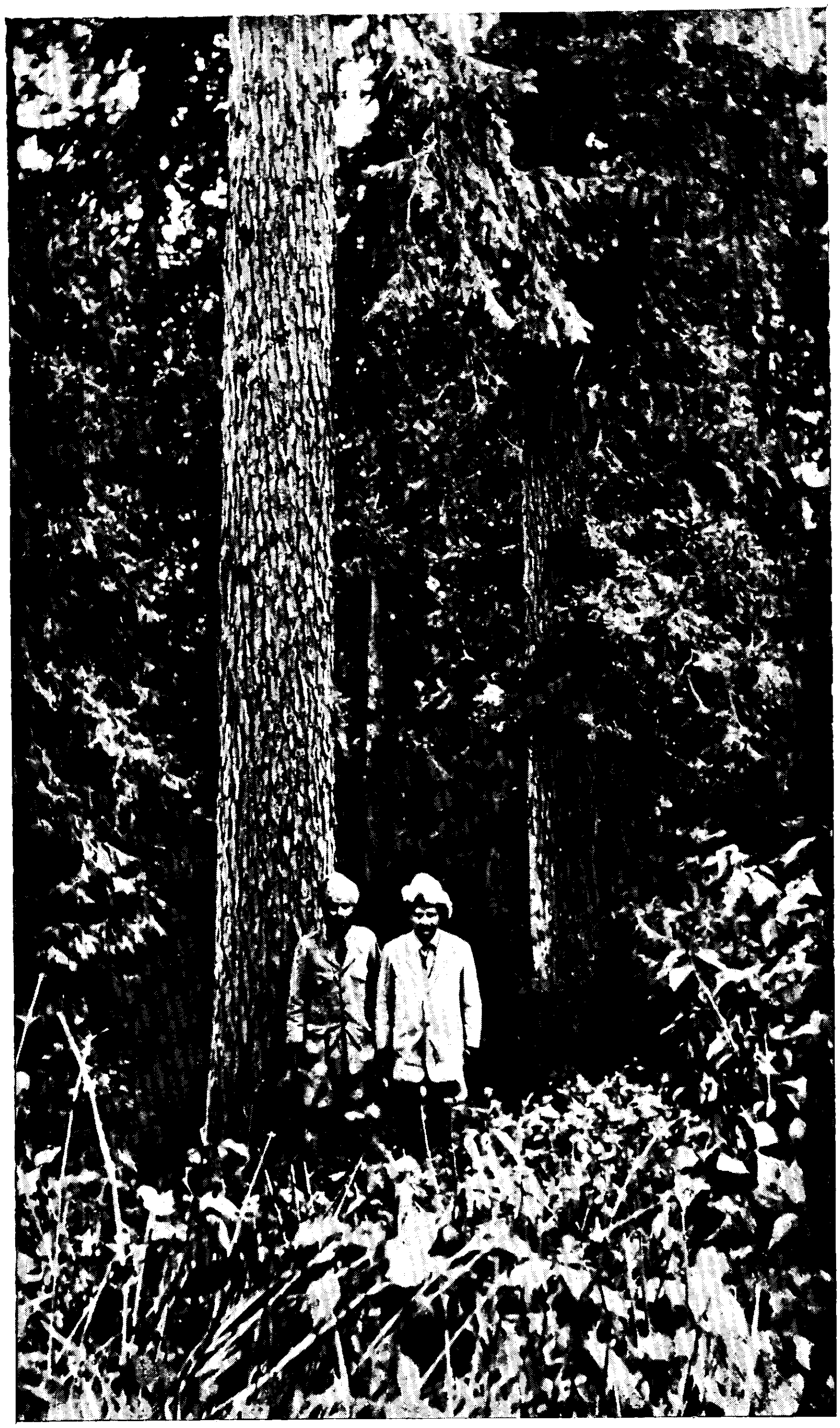
aeration which are unsuitable for the development of roots of fir seedlings.

The humus condition under openings made in the canopy by different types of felling varies markedly and in general, is correlated with the light and evaporation climate. Direct exposure of humus to the sun produces partial sterilisation, and retards the process of decomposition by killing the micro-organisms and reducing their activities. Similarly, local climate characterised by a rapid or early rise of surface temperature and evaporation is unfavourable for the continued growth of fir seedlings on account of lowering of the moisture contents of humus. The superiority of strip fellings over shelterwood fellings is evident on these grounds.

2. *The washing away of nutrient materials from the neighbourhood of growing roots into the deeper soil layer.*—The poverty of nutrient salts favours plants and herbs which extract nourishment from the superficial layers of soil with the low salt concentration. The dominant type of vegetation therefore consists of grasses and herbs possessing rhizomes (*Strobilanthes*, ferns, iris, etc.), mosses and a few low shrubs.

3. *The prevailing high Hydrogen-ion concentration.*—Sufficient data concerning the Hydrogen-ion relationships of fir seedlings are not yet available. The following table gives by horizons the range of Ph value of soils under spruce forests :—

HORIZON.	PH VALUE.		
	Sample 1	*Sample* 2	*Sample* 3
A_0	6·70	4·60	6·98
A_1	6·83	4·74	7·85
A_2	6·27	4·71	7·53
B_1	5·45	4·71	6·97
B_2	5·05	4·86	6·42
C	4·69	4·99	6·55



SILVER FIR IN NAKAS FOREST NEAR PULGA SHOWING DENSE MONSOON HERBAGE, KULU DIVISION, PUNJAB

Photo : H. Tireman.

It is believed that the range is similar in the case of soils under silver fir forests as well. It is evident that fir seedlings occur on a fairly wide range of Ph values, which alone does not explain the differences in the behaviour of natural regeneration. Most likely Hydrogen-ion concentration becomes an unfavourable habitat factor when it operates in conjunction with certain other factors of the soil. For instance the toxic effects of Hydrogen-ion may be attributable to the increased solubility of aluminium, or changes in the micro-flora and fauna of soil.

The toxicity of Hydrogen-ions can be reduced on small areas directly by liming. On extensive areas in the forests, the same results can be obtained by maintaining a cover of deciduous trees and shrubs, or artificially raising such a cover where it does not already exist. (Investigations with quick growing poplars to test their value for providing the desired cover are in progress.) On their decay which is fairly rapid, the leaves of deciduous trees restore to the upper layers their calcium contents drawn up from the soil below.

Undergrowth Relationship.

References have been made by several observers to certain plants as indicators of good or bad soil conditions in relation to the natural reproduction of fir seedlings. Other observers have made out botanical lists of plant species and associations characteristic of such soil conditions. Still others have taken an extreme view and regarded ground flora, collectively referred to as weeds, as highly injurious to the influx and establishment of fir seedlings.

The point cannot be over-emphasised that very great rigidity in the interpretation of plants as indicators is undesirable. The problem cannot be solved for the practical forester by making a sample list of "good" or "bad" species. Not only the environmental complex varies from point to point and in a complicated manner, but the responses of plants themselves differ within wide limits.

The absence of natural reproduction under *Indigofera* and its associates generally considered as indicators of favourable conditions is not an infrequent occurrence.

The appraisal of the value of undergrowth, as a factor of habitat should be based on the study of the habits of plants, shrubs and herbs, in respect of possession by them of certain undesirable characters.

While work along these lines is in progress, it will be sufficient here only to outline the basis of assessment.

Growth habits.—Plants which grow rapidly, densely and gregariously are undesirable, *e.g., Strobilanthes,* balsams, etc. Plants with crowns above the ground, which protect the ground against direct insolation and early heating, and promote the activity of earthworms and micro-organisms are most useful. The density and spread of crown in relation to its height above ground is an important factor contributing to the usefulness of such plants.

Nature of tissues.—Plants with soft and sappy tissues capable of rapid decomposition are useful. In general, the extreme "competition forms" of pioneer plants, and tall herbs which colonise the thick humus layer in the large openings made by the manipulation of the canopy are rapid growers, exhibiting economy of tissue material in the structure of their bodies, *e.g.,* hollow stems characteristic of balsams, etc. Under the action of direct light, their decomposition, however, is arrested, and so the thick matted layer composed of half-destroyed stems is inimical to the germination and development of fir seedlings. On the smooth polished surface of such vegetational material, the seed of fir fails to find a lodgement. The relatively low and soft herbs mostly characteristic of the spring flora are quite harmless.

Root habits.—Plants of which the root activities are confined to the same stratum as the fir seedling roots are injurious by reason of competition which is the crux of the whole problem. The issue of this competition depends upon a number of factors including reserves of nutrient material and of moisture present in the soil. On exposed situations and poorer soils, the competition attains a greater degree of significance, and results in heavy casualties among fir seedlings.

Plants with thick and closely knitted rhizome masses formed beneath the upper layers of soil prevent the penetration of seedling

roots, and produce unfavourable conditions in the deeper layers of soil beneath.

Plants with deeply penetrating roots which break up the soil by the decomposition of roots are useful.

Feeding habits.—Plants which draw upon the same nutrients as the fir seedlings roots are injurious. The more the differences in the feeding habits, the greater the harmony in which they live with fir seedlings. Such plants so far from being competitors may be even complementary, involving no interference with the seedling development.

In general, broad-leaved trees and tall shrubs are useful in spite of their woodiness. Their leaves decay rapidly, and roots open up the soil. Under the shade of their crowns, the soil is protected against insolation, and the activity of earth-worms and useful micro-organisms is favoured. These effects explain the value of a temporary crop of poplars alluded to before.

Grasses with thin trailing habits do not offer any disadvantages, but with thick tufty habits are bad.

Seed Germination Relationships.

Silver fir cones which mature in October are borne on upper shoots mostly confined to the top end of the stem. The number of cones on a single tree is usually small, and the proportion of fully ripe seed at the time of its shedding is relatively low.

Of all the conifers, fir seed has the poorest germinative capacity, as shown by the statement below :—

Species			*Germination per cent.*
Silver fir	..	..	25
Spruce	..	..	35
Deodar	..	..	62
Kail	..	..	50
Chil	..	..	75

The above figures of germination percentage refer to selected seed sown under optimum conditions provided in the nursery, and, therefore, closely approximate their maximal value.

In the forest, conditions of a much poorer germination (not exceeding 10 per cent.) takes place on account of the prevailing unfavourable conditions arising from vegetational covering, thickness of humus layer and temperature and moisture relationships of surface soil.

In the research nurseries at Manali, the seed sown on beds with 3″ covering of litter and half decomposed humus failed to germinate, due to surface drought which is largely of physiological nature.

The initiation and duration of germination period is correlated with the temperature climate. Under heavy opening in the canopy favouring early and rapid rise of surface temperature, the period of germination is reduced. The survival of seedling is, however, greater under conditions which permit only gradual warming up of soil, as moisture contents are maintained for a longer period above the minimum water requirements.

The poverty of seed harvest, and unfavourable temperature climate under heavy seeding fellings, offer serious disadvantages, compared with strip fellings.

Except in a year of heavy seedfall, the results of germination are poor on account of the combined effect of low germinative capacity and other unfavourable habitat factors.

Tests carried out at Manali clearly indicate that fir seed loses viability after storage for a period of eight months.

Oecological Status of Fir Forests.

The œcological status of fir forests has been examined by various observers from the point of the theory of œcological succession and climax formation, and views have been expressed in support of the stability of fir forests in the altitudinal zone in which they occur. In other words, these forests are held to be in a state of equilibrium with the influences of climatic factors, and so have a claim to be regarded as formations of the climatic climax type. If this view were correct, all other formations occurring within the climatic zone would be expected, in the absence of any disturbance and after a course of evolutionary changes, to reach a final stage in the establishment of fir forests.

More recently, Glover has drawn attention to important œcological changes in the coniferous forests. He has pointed out that the climatic zone of fir forests instead of exhibiting any rigid boundary extends into the zone of high level blue pine and *kharsu* oak. On the other hand, the very noticeable absence of natural reproduction of fir forests in the typical fir zone suggests the instability of these forests which is more likely of the fluctuating type rather than a permanent change.

It is held on plausible ground that the concept of climatic climax is a very narrow one, and that there occur in addition stable edaphic climaxes which œcologically are of the same status as the climatic climaxes.

In fact, the test of a climax must include consideration of the maturity of soil profile in relation to climate. The mere existence of a species in a habitat without reference to the degree of maturity of soil is not a conclusive evidence that climax stage has been reached.

Recent researches on the fir soils of the Kulu division show that these are immature podsols in which the process of podsolisation is far from complete. The partial impoverishment of the upper layers of mineral soil by leaching and the incipient formation of pans may be only early stages of the more advanced changes for which the environment is being prepared.

If such progressive soil changes attributable to natural causes continue, changes in vegetation are inevitable. The climax dominants of the past edaphic climate may cease to be able to maintain themselves, and the structure and composition of the previous climax may become radically different.

It is not proposed in the researches in hand to attach much practical significance to the influence of potential and speculative phenomena such as those described above. For the explanation of the causes of failure, only when the resources of all the known straightforward factors of the habitat have been thoroughly exhausted, will it be necessary to turn the attention to the elusive and subtle factors of succession.

THE PRACTICAL PROBLEM OF THE MANAGEMENT OF THE HIMALAYAN FIR FORESTS

BY H. M. GLOVER

Market conditions.

The Himalayas contain large areas of virgin spruce and silver fir forest which have not been worked for export on account of their remoteness from the markets of the plains and the low sale price of fir timber, the cost of extraction being so high as to render unprofitable the extraction of any timber other than scantlings of large dimensions, which are sawn *in situ*. Of late years the North Western Railway has bought about 20,000 B. G. sleepers annually, but in the general market fir timber is saleable only when cheap supplies of other coniferous timbers such as deodar, *kail* and *chir* are not available. There is at present no demand whatever for wood pulp at prices which yield a profit.

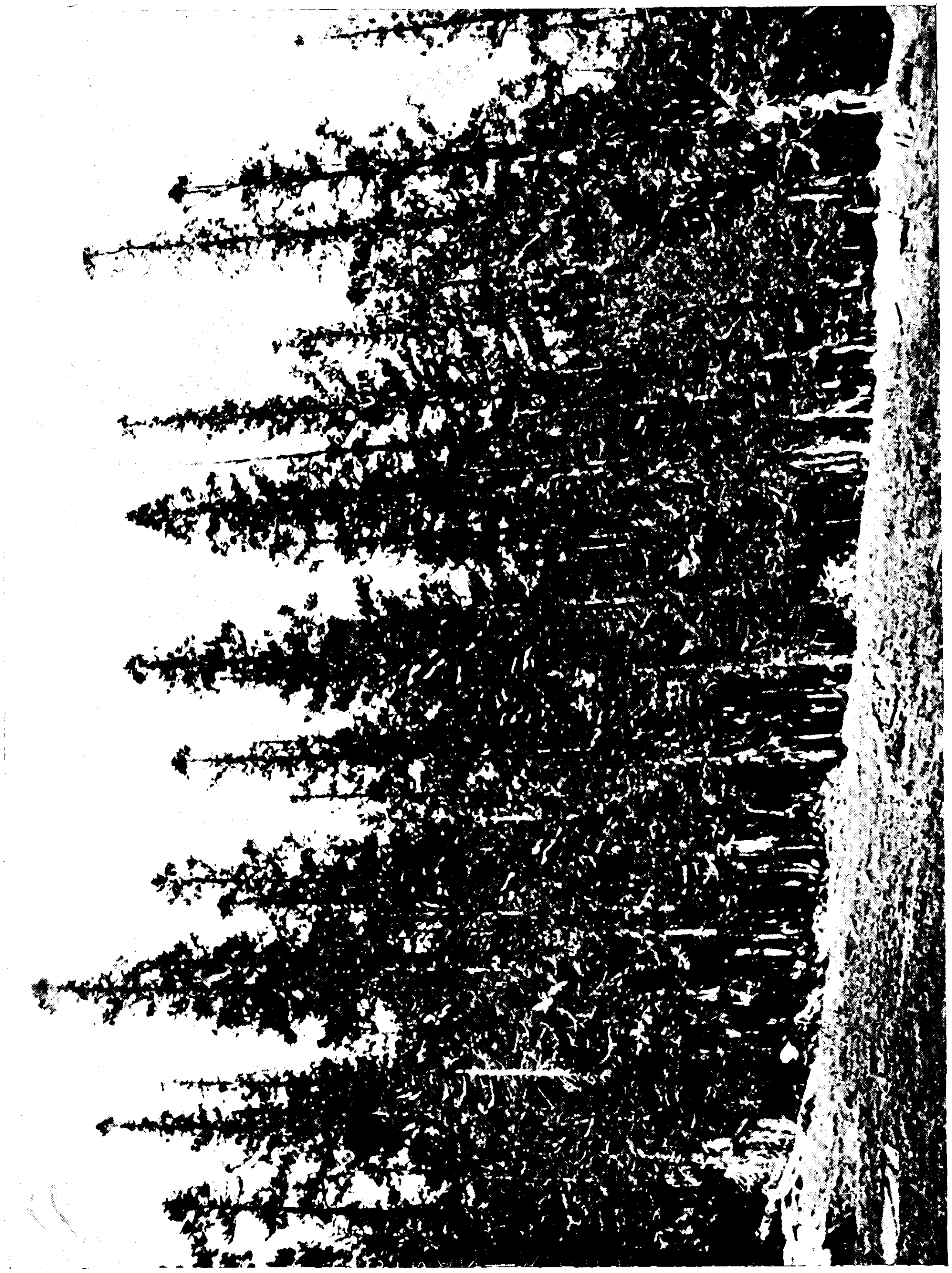
Grazing.

The fir forests lie at high elevations, as already noted, and are subject to grazing rights; but with the exception of those near villages or routes of emigration they are not heavily grazed. The damage done varies with the intensity of the grazing; throughout this article it has been assumed that grazing can be controlled, and that forests can be closed to grazing when and where closure is required.

General description of the fir forests.

The fir forests occupy large areas in the inner Himalayas at elevations of 8,000 feet upwards, and, owing to their remote situation, are more expensive to exploit than are the deodar, *kail* and *chir* forests, which lie at lower elevations. Spruce and silver fir trees frequently occur in deodar and *kail* forests, where they regenerate well, and trees are sold to traders at low prices with the object of clearing the ground for the growth of more valuable species.

The fir forest proper lies at elevations which range from 8,000 to 10,500 feet; at the lower elevations spruce preponderates, but at higher elevations the silver fir grows in pure woods. The trees reach magnificent dimensions, and sometimes comparatively large tracts of over-mature forest are met with, which give a false idea of even-aged high forest. An analysis, however, shows that



SILVER FIR NEAR TREE LIMIT AT THE HIRANGHATTI PASS, UPPER BASHAHR DIVISION, PUNJAB
EXCELLENT NATURAL REGENERATION IN FOREGROUND

Photo : H. G. Champion.

there is a marked degree of irregularity, as is shown from the following results of a test enumeration over 160 acres of the fir forests of the Pabar valley.

Stock per acre

Diameter at breast height in inches

Species	16-20	21-24	25-28	29-32	33-36	over 36
Numbers of mixed silver fir and spruce trees ..	9·4	7·5	6·4	5	3	12
Standard volume (cubic feet in the round quarter girth) ..	60	110	180	250	300	330
Total volume ..	534	825	1,152	1,250	900	3,960

Total volume per acre—8,651 c.ft.
Weight of timber per acre—170 tons.

Speaking generally, trees are sound up to 30″ to 32″ diameter, but above these dimensions many are hollow. The exploitable diameter is about 28″ to 30″. Trees of less than 24″ diameter have practically no value.

It will be noticed that the enumeration figures show that (*a*) there is a large proportion of trees of above the exploitable diameter; (*b*) the lower age classes are fairly well represented. We have already commented on the fact that trees of diameters less than 24″ are practically unsaleable, and it is obvious that forests of the type occurring in the Pabar can best be managed under a selection system, which actually has been prescribed and is suitable, as in the Pabar natural regeneration is ample.

Mature and over-mature forest, and the results of shelterwood regeneration fellings.

In other localities, however, compact areas of mature or over-mature fir with no advance growth are met with, to which the selection system is not suited, as the felling of individual trees merely leads to increased growth of dense herbage. In such areas in the Parbatti Valley (Kulu) true shelterwood fellings were made in 1917. The refuse from felling and sawing was very heavy and burning was expensive, the initial preparation of the seed bed costing Rs. 15 per acre. Deodar, ***kail*** and fir seed was sown and weeds were kept down. At first growth was very slow, but now the fir plants are growing well, and a fair amount of natural regeneration has appeared, particularly on ridges and under bushes. Where felling and sawing refuse was not burnt, a few seedlings are now appearing, but the process of natural

regeneration appears to be very protracted. In Lower Bashahr, where similar shelterwood fellings were made in 1930 in mature fir forest, the results have not been satisfactory, chiefly on account of the dense monsoon herbage and the difficulty and cost of getting rid of felling and sawing refuse. It is possible, however, that sufficient time has not elapsed for fir seedlings to become established, and that the final result may be more satisfactory than at present appears to be probable. The writer is of opinion that regeneration can be obtained to a satisfactory extent only when refuse is thoroughly burnt, and when burning has been followed by a proper and thorough preparation of the seed bed, artificial sowing or planting, and tending at a high cost, such as is not justified under present trade conditions. The light factor, within limits, appears to be of little importance as regards the securing of reproduction, but when the initial seeding fellings are light the refuse from subsequent conversion of the trees left as seed-bearers is so heavy as to form a most serious obstacle to the establishment of the regeneration obtained after the seeding fellings. It is essential that the first seeding fellings shall be as heavy as is sylviculturally permissible, in order that as much refuse as possible shall be got rid of at the first operation. It has been mentioned that the stock of timber per acre averages 170 tons : of this amount over 100 tons per acre is refuse, and its removal is both costly and difficult. Under present financial conditions it is quite impracticable to incur the large expenditure on refuse burning and artificial work necessitated by large scale operations under the shelterwood system.

A study of natural regeneration in varying types of fir forest.

Before a decision is reached as to the sylvicultural system to be adopted it is desirable to study the conditions under which natural seedlings occur in differing types of virgin forest and the methods which Nature follows in forming fir forests.

(a) Mixed broad-leaved trees and fir forest.

At high elevations there is much broad-leaved forest, particularly birch (*Betula utilis*), oak (*Quercus semecarpifolia*) and maple. There are also large areas covered with bush rhododendrons and willows. In all these areas, except where sheep and goat grazing is heavy, and sometimes

even close to grass pastures, there is ample silver fir reproduction. Reproduction of both silver fir and spruce also occurs plentifully at lower elevations under broad-leaved trees, such as bird cherry, and bushes. It would appear that an adequate mixture of broad-leaved trees and bushes has a most favourable effect on the natural regeneration of silver fir and spruce, and that any system adopted must maintain this mixture. Fir seedlings, particularly silver fir, are very tolerant of shade, and after years of suppression develop rapidly when the overhead cover is removed. It would, therefore, appear that the selection system is admirably adapted to the reproduction of fir in these forests.

(b) Mixed conifer forest.

Large areas of *kail* and deodar forest have been invaded by silver fir and spruce which regenerate with ease under the shade of these species. In such forests shelterwood fellings in favour of the more valuable deodar and *kail* result in a satisfactory admixture of fir species, particularly where cultural operations follow exploitation, as the working of the soil and the eradication of dense herbage produce conditions under which fir regenerates with ease. If some modification of the shelterwood system is not adopted, the invasion of the fir is so prolific as to convert deodar and *kail* forest to woods in which fir is dominant, and there is no doubt whatever that the ultimate fate of these forests will be the formation of fir forests with a sprinkling only of more valuable species. The writer is of opinion that many of the existing fir forests were formed by the invasion of fir in broad-leaved or deodar and *kail* forest, as is proved by the survival of a few isolated broad-leaved trees, old deodar and *kail* trees, and by dead trees and stumps.

Over-mature fir forest.

Let us now consider the case of the mature and over-mature fir forest.

The silver fir and spruce trees are of great age and large dimensions, and at first sight appear to be of true climax type, but this appearance is deceptive as there is no reproduction of silver fir or spruce, and, as the aged giants die or are blown down by wind, or are broken by snow, their place is slowly taken by yew (*Taxus baccata*) and broad-

leaved trees. More often, however, the soil is covered only by dense herbage. The fir forest appears to be incapable of reproducing itself directly, and the apparent climax forest is not permanent. The soil is covered by a thick layer of humus and herbs which prevent reproduction. These herbs consist of two different types—(*a*) small plants which appear soon after snow melts, and consist of species such as Aaron's rod, the maidenhair fern and violets which are favourable to regeneration ; (*b*) dense herbage which appears during the summer monsoon, and consists of *Strobilanthes,* balsams, *Dipsacus* and other species which, when they die, form a thick mat of decayed vegetable matter. Humus and monsoon herbs appear to prevent regeneration of silver fir and spruce, but broad-leaved species with heavy seeds such as horsechestnut and yew occasionally grow. On broken ground, on ridges where the soil is well-drained, and on freshly turned earth, as, for example, where trees have been uprooted or where the soil has been laid bare by avalanches, spruce and silver fir seedlings are met with, and the reason appears to be that in such places herbs do not flourish or are absent and form no sufficient impediment to the growth of fir seedlings. After many years, when felling refuse has decayed, seedlings grow on decayed wood chips and on the boles of fallen trees, a similar effect which may be due to the absence of weeds.

The choice of methods of regenerating the dense over-mature forests would appear to be between :

(*a*) clear fellings,

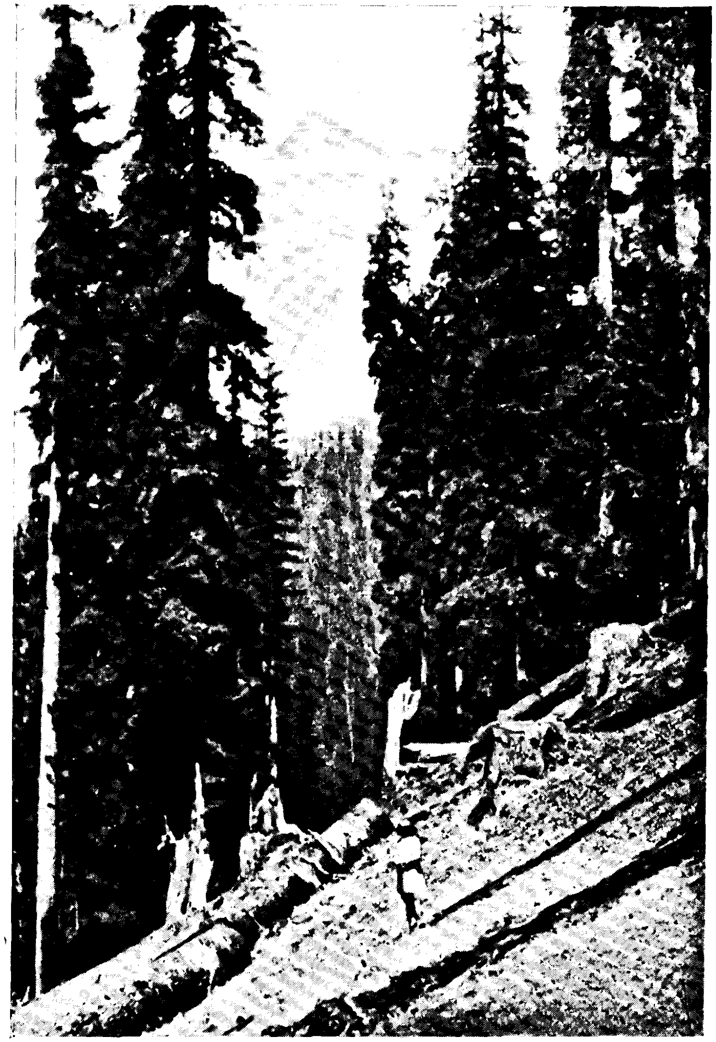
(*b*) shelterwood fellings,

(*c*) strip fellings,

(*d*) modifications or combinations of the above.

(*a*) *Clear fellings.*—Clear fellings are likely to be followed by erosion and a lowering of the factors of the soil, and therefore extensive clear fellings are not permitted in the Himalayas, as it is essential to maintain the forest intact in view of the important role it plays in protecting the catchments of the Punjab rivers.

(*b*) *Shelterwood fellings.*—The cost of cultural operations following on shelterwood fellings is prohibitive in true fir forest. Where,



SILVER FIR FOREST ABOVE PULGA, BANDAG 2/3, NEAR FIR REGENERATION EXPERIMENTAL PLOT, KULU DIVISION, PUNJAB

SHELTERWOOD FELLINGS IN MATURE SILVER FIR FOREST. GROUND COVERED WITH FELLING REFUSE AND *Strobilanthes*. NALABAN, SHOLI RANGE, LOWER BASHAHR DIVISION, PUNJAB

Photos : H. M. Glover.

however, the fir occurs in localities where there is a reasonable chance of re-establishing deodar and *kail* forest, shelterwood fellings are followed by the standard operations of refuse-burning, sowing and weeding. In order to make success reasonably certain deodar, *kail*, spruce and silver seed are sown together. Shelterwood fellings are not favoured over large areas, both on account of the lack of certainty of natural regeneration and on account of the high cost of artificial reproduction.

(*c*) *Strip fellings.*—These, to be of value, must run vertically up and down hill, as in this way alone can extraction be carried out cheaply. As has been seen from Mr. Mahendru's article there is some small hope of natural seedlings appearing. At any rate, extraction and the disposal of refuse are facilitated, and cultural works can easily be undertaken. On the borders of the strips shelterwood fellings may be undertaken, and the strips can be broadened as required after the centre has been restocked artificially or naturally.

This process is modelled on that introduced in Austria some few years ago as a compromise between the clear-cutting system, which gave special facilities for extraction but entailed a permanent lowering in the quality of the soil, and the shelterwood, group, selection or other silvicultural systems, the first of which was considered to be risky over large areas, and the others involved high timber extraction costs which rendered their operation too costly.

Conclusion.—In the Punjab it has been decided that in true fir forest wherever the constitution of the forests permits, trees shall be marked according to the principles of selection, with the object of avoiding expense on artificial regeneration; that where there is a reasonable chance of introducing deodar and *kail* shelterwood or strip fellings shall be made, to be followed by refuse-burning and the artificial introduction of valuable species. The decision as to the method of fellings is left to the Divisional Forest Officer, who, however, is not permitted to make clear or regeneration fellings over extensive areas. It has also been decided that experiments shall be carried out by the Silvicultural Research Division until the correct

technique of regenerating the fir forests of the Himalayas has been ascertained.

Mr. Mahendru's paper is of interest as it shows the progress made in analysing the factors which influence reproduction. The second portion of the paper has been written in order to show the practical difficulties, particularly those related to finance and management, which limit the choice of methods to those which are reasonably cheap and easy of application, and which do not involve either large expenditure on artificial regeneration or the sacrifice of immature trees.

DISFORESTATION

BY "AMIMAD ORISHE."

Not long ago an application was sent to the Government by a few individual villagers asking that a considerable area of reserved forest—8 compartments—should be disforested to provide them with land. In the correspondence which ensued the view was put forward that, as a matter of principle, *each and every application of this sort should be dealt with on its merits by the Forest Department which must show full justification for refusing to grant the request.* If I asked forest officers generally to say who, they thought, was the originator of such a principle the majority would, I think, reply that he was a collector or deputy commissioner with too great an inclination to be the all too indulgent father of his people. To these forest officers, as to myself, it will be a real shock to find that the author was in fact a forest officer, and one by no means without influence. Such views are, I submit, completely revolutionary, and if held in high places, certain to prove a cause of very serious embarrassment to our successors because it is, alas, all too certain that such applications will become more and more numerous and insistent in the near future. It is for this reason that I am raising the subject of disforestation in the pages of the *Indian Forester* in the hope that if similar revolutionary views are held by others I may be able to persuade these heretics to return to the orthodox fold, or, at any rate, to admit that there is something

to be said on the side of the Forest Department when it claims security of tenure of its lands.

My view, and I hope it is also the view of most forest officers, is that disforestation should only be considered when it is desirable in the department's own interests, or when the civil authorities (not individuals) have taken the matter up and have been able to show the Government that there is a real and pressing necessity for disforestation and that the interests of a considerable local community (not individuals) far outweigh those of the general public for whose benefit the reserves were constituted. If, and when, Government is satisfied that disforestation is desirable, a re-settlement should take place and in cases in which only partial disforestation is decided on, the question of the rights granted in the original reserve should be reconsidered with a view to their reduction. The idea that we should go down on our knees and grovel and beg for mercy by "justifying" ourselves each time some one with an Ahab complex demands a slice of reserve seems to me to be ridiculous. Perhaps those who are so poor-spirited as to hold such views may take heart, if I point out that they are contrary to the spirit and the letter of the Forest Act, which prescribes that once a reserve is formed no new settlers can claim any rights, nor can any form of right accrue. Doubtless, those who framed the law and thought, as I do, that surplus population might move to surplus land were hard-hearted and unsympathetic.

The Forest Department is after all of some importance. It is not a greedy ogre which has grabbed, by cunning, vast areas of delectable land and obstinately clings to them for its own benefit and to no useful purpose; nor is it a dog sitting in a manger and refusing the unfortunate horse access to its feed. It is a revenue producing department which saves the general public large sums which would otherwise have to be exacted in the form of taxes, but still more, is it a department which ensures the general public a supply of forest-produce which is absolutely essential for its well-being and comfort? Moreover, it is the accessible reserves, which the local Ahabs wish to grab, that confer the greatest benefit by reason of the cheapness of extraction. The Forest Department is and always has been and always

will be regarded by the short-sighted and ignorant and the "peace and an easy life at any pricers" as oppressive, because it frequently interferes with *individual* requirements. Surely it is most distressing to find that there are forest officers themselves who are so uncertain of the utility of the department in which they are serving, that they need to justify its claims to its own land, which has been acquired only after the most detailed and exhaustive enquiry. Could the inferiority complex go lower? I for one decline to creep about the province justifying the existence of my department and profession. (For what are we if we have no reserved forests?) The justification for both is self-evident and the justification for the reserves is the settlement proceedings and the recommendation of all concerned in them and Government's own orders. I believe that "What I have I hold" is a good motto (possibly too belligerent for these spineless days) which by no means precludes a graceful generosity when requests are made from the proper quarter, and sound and cogent reasons are provided to justify the granting of them.

If the use of reserves against cultivation is fairly considered it cannot be denied that reserves interfere far less than cultivation with the liberties of the parochial population. Squatters may take up land anywhere, and fell trees and other forest-produce, and destroy forests without any form of enquiry or the granting of any rights, and the areas over which they work are, in the aggregate, vast. Leases are given out of large areas after enquiries which are most perfunctory in comparison with the settlement proceedings of a forest reserve. No rights are granted and the areas are usually fenced so that grazing is prevented and paths and cart tracks blocked: any timber on leased areas ceases to be at the disposal of the local inhabitants. Yet every other form of cultivation pleases and only the cultivation of trees is considered vile—by some forest officers.

In considering any question of disforestation it should be remembered that forests are to last for ever and that the destruction of the work of our predecessors merely for a present apparent benefit may, and very likely will, cause embarrassment in the future. Forestry is a long sighted occupation and has no concern or connexion with

opportunism. One has only to remember the part that forests (and particularly accessible forests) played during the war to be convinced that allowances must be made for the unexpected and that an enquiry as to the "justification" for forests on the basis of the needs or facts of the moment would be extremely short-sighted and inevitably lead to the perpetration of egregious follies.

Unless the Forest Department has security of tenure of its lands it is impossible to work the forests to the best advantage. The time, labour and expense involved in enumerations and the preparation of working plans will be largely wasted, and complete reorganization of coupes and felling series may be rendered necessary by disforestation. Yet, I gather, we are to waste our time "justifying" the retention of any piece of our reserves that any individual villager may happen to desire !

There is finally quite another point to be considered. Government requires forest officers to put forward the forest point of view. No honest Government wants us to be humble, worm-like toadies and look at things from every other point of view but our own, and subordinate our interests to those of others. To do so would be, as it were, to take upon ourselves the duties of the Government itself and decide between the varying interests and thereby automatically deprive Government of the advice it needs. Other interests are quite competent to protect themselves without any unasked for help from us.

I am assured that I shall obtain no support for such views. I can hardly believe it, but to test the matter I would ask those who are sufficiently interested to express their views in the *Indian Forester*. Failing this, perhaps the Editor would write a brief note on the subject. If opinion is against me, I think that a new motto is required for the department and I suggest—

> "Vertebrate we stand : Spineless we crawl" (and quite rightly get trodden on).

MARTESIA : A MARINE BORER.

BY C. F. C. BEESON,

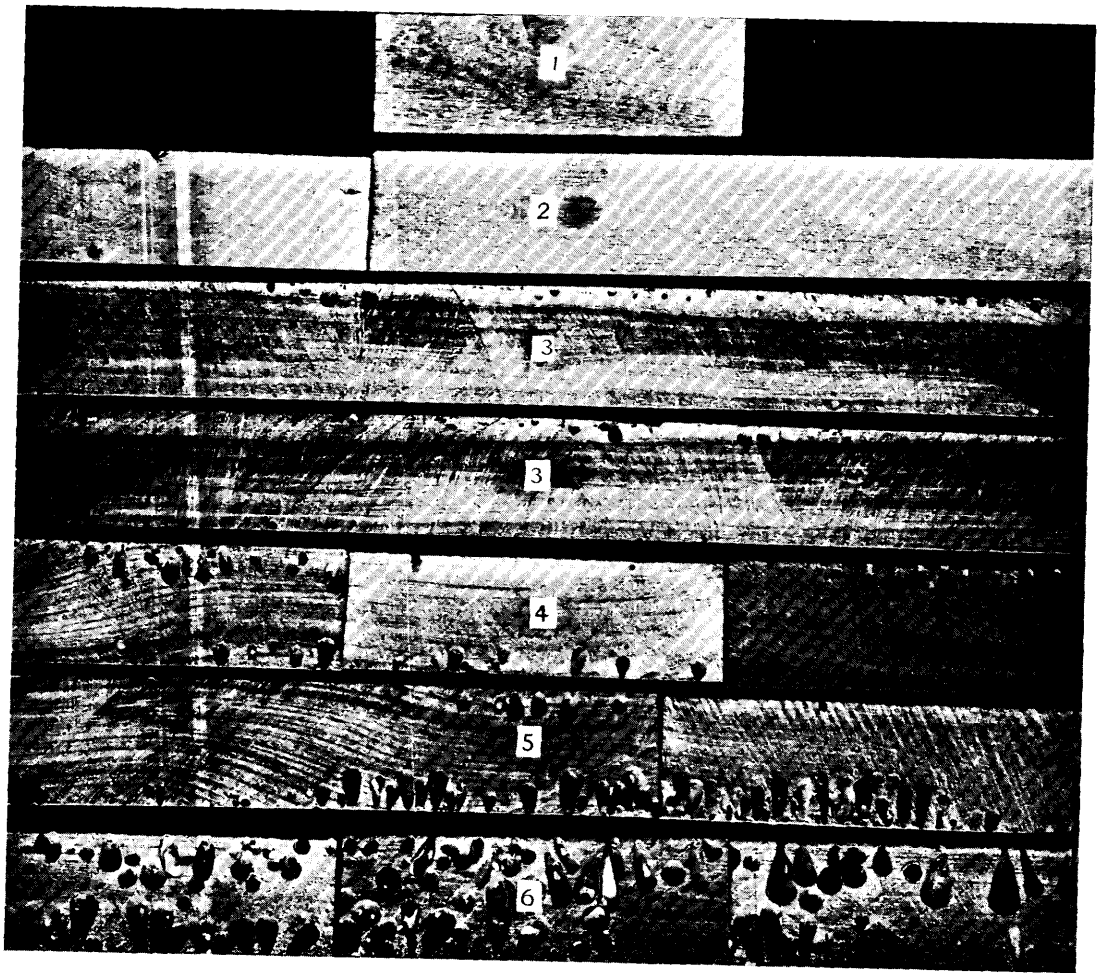
Forest Entomologist.

Damage to timber and wooden structures in sea or brackish water is generally, but not always, correctly assigned to teredo. Species of *Teredo, Bankia* and *Xylotrya*, which are the true shipworms of Indian harbours, are usually accompanied and often replaced by other species of marine borers. One of the latter is *Martesia striata* L., a common species of the Indo-Pacific Ocean ; its habits were recently studied on the west coast of Madras at the mouth of the Beypore River south of Calicut.

Another species, *Martesia rivicola* Sowerby, occurs in the estuaries of the Ganges and Irrawaddy, the Gulf of Siam, the Dutch East Indies and Ceylon.

Martesia striata is a pholad mollusc resembling a mussel, with the body of the animal wholly enclosed in the pair of shells and not drawn out into an elongated worm-like form as in the typical teredo. It lives in a cell excavated in the wood by means of the cutting edges on the shells ; the cell is of the same pear-shaped form and size as the mollusc, which does not exceed 2½ inches in length. The food of the wood-boring mollusc consists largely of fine organic detritus and microscopic plants and animals occurring in sea water. Feeding is effected by means of a pair of siphons which are muscular tubes projecting through the small hole on the surface of the wood that marks the aperture of the cell. By means of numerous microscopic hair-like structures (cilia) beating in one direction, a current of water is drawn in through one of the siphons, passes through the body and is expelled through the other siphon. The water in its passage comes in contact with the gills of the mollusc, where it supplies its oxygen to the blood, while the food material is filtered out and carried to the digestive organs. The discharged water takes with it the waste products of the body and also the wood-dust produced by the excavation of the cell.

At the spawning season eggs are fertilised and give rise to free-swimming larvæ. The minute larva has a bivalve shell and a



MARTESIA STRIATA ; A MARINE BORER

The pieces of teak wood are 2 × 2 inches square in cross-section ; the dimensions are reduced to about five-eighths of an inch in the photograph.

Piece 1 was immersed for 1 month in November ; the borer holes are pinpricks and scarcely visible.

Piece 2 was immersed for 2 months in November-December ; the borer holes are mainly pinpricks but a few reach a depth of one-eighth of an inch.

Pieces 3 were immersed for 3 months in the cold season ; the largest holes are scarcely half an inch deep.

Pieces 4 and 5 show the rate of development in the warmer water of the early part of the year.

Piece 6 shows the development that occurs in 3 months from larvæ settling in March ; the *Martesia* cells reach a length of one and a quarter inches.

Under longer periods of exposure and in large pieces of wood a cell depth of two and one half inches may be attained.

swimming organ and a crawling organ. Eventually it settles on the surface of wood and penetrates by means of a hole that is no larger than a pin-prick.

The periods at which these stages in the life-cycle occur, and the rate of development of the borings of *M. striata*, are important factors in determining the liability of timber to damage and the measures required to prevent damage. Information on these points was obtained by immersing samples of wood (teak) at intervals of a month throughout the year and leaving them immersed for periods of one to eleven months. The work was done at the Forest Departmental depot at Beypore on the mouth of the Beypore River and at the New Malabar Timber Yards, Kallai, a few miles up-stream, between May 1933, and September 1934.

The settlement of the free-swimming form of *Martesia striata* begins annually in November and continues until the following June. The development of the boring stage during the first month is represented by superficial pin-pricks (see Fig. 1). During December, penetration occurs to an average depth of one-eighth of an inch from the surface (Fig. 2). The billets in Fig. 3 show the penetration in three months from November larvæ.

Those larvæ settling during the first five months of the year grow more rapidly. The billets in Fig. 6 show the penetration in three months from larvæ settling in March. The examples in Figs. 4 and 5 show the slower rate of development during three months from cold weather larvæ.

Three months in the first half of the year is sufficient for the mollusc to grow to a length of $1\frac{1}{4}$ inches, and to riddle completely test-pieces of 2×2 inches cross-section. The fully mature size of *Martesia striata* is probably over 2 inches long and three-quarters of an inch in diameter at the base, but owing to crowding this was not attained in the experimental material.

When the monsoon flood-waters come down the river in June the borers in the wood are killed, and the free-swimming population disappears. The lethal salinity is apparently below three parts per thousand,

At the river-mouth the intensity of attack is very much more severe than at a few miles upstream. The salinity of the water at the latter place is, however, sufficient to permit the full development in size of *Martesia* and the growth of oysters (*Ostrea picatula* Gmelin) with a $3\frac{1}{4}$ inch shell as well as barnacles and encrusting organisms.

Permanent breeding occurs on the sea-coast and the lower incidence upstream is due to the thinning out of the larval population during migration and the absence of local breeding until late in the hot season. But it would be necessary to go a considerable distance upstream to find a site for a timber depot that would be permanently beyond the limit of distribution of marine borers.

Damage can nevertheless be prevented in tidal waters by adopting the following remedies :—

Floating.—Timber floated down during the monsoon can be left in the form of rafts in depots at the river-mouth till the end of the year without incurring damage more serious than superficial pinholes. In January the rate of development of the borers begins to be more rapid, and the formation of holes of the size of small shot with a minimum depth of an eighth of an inch may be expected. Timber should be removed from tidal waters at the latest by the beginning of January. If sold at this period it can be guaranteed free from marine borer defect, provided the purchaser agrees to remove to land in a week or so.

When floating has to be continued late in December or in January, the date at which rafts enter tidal waters should be taken into consideration, and the subsequent period elapsing before logs are put on to land should not exceed one month.

Dry storage.—Timber that must be stored at the river-mouth after the end of December should be dragged above high tide level, and must be on dry land from mid-January to mid-May. Logs *can* be put into water again, if desired, from mid-May ; pinholes which begin to form during this month will be checked by the south-west monsoon floods.

If the holding of a large stock of timber throughout the year is contemplated as a regular practice, and dry storage cannot be

arranged, the only alternative is to construct a storage pond of fresh water.

Wet storage.—By means of a dam of suitable design across a re-entrant or the end of a creek, a storage pond can be filled during the monsoon with non-saline water free of borers, and can be isolated from the saline waters of the first half of the year. Such a log pond would be suitable for storage, but would not allow through traffic. Logs could be taken out or brought in on the land side at any time, but extra material could not be floated in from the water side between September and June.

A complete earth dam is required to prevent seepage ; a sluice gate would not be effective. Annual refilling with water and logs rafted in the earlier monsoon operations, could best be done by means of an elevated spillway giving inflow at high tide and requiring the minimum of earthwork for final closure after filling. The dam should be closed by the end of September. Timber arriving later than September would have to be hauled into the pond *via* the bank side.

THE REGENERATION OF TROPICAL EVERGREEN FORESTS

BY H. G. CHAMPION,

Sylviculturist, F. R. I., Dehra Dun.

From an interesting article in the January number of *The Malayan Forester* from the pen of Mr. J. G. Watson (pp. 20-23), it is evident that the Indian Forest Service as a whole, and particularly as represented by the delegates to the fourth Sylvicultural Conference held at Dehra Dun in October 1934, owe an apology to the Malay Forest Service—an apology which I am sure we would all like to make at the earliest possible moment. Feeling that my own guilt is perhaps greatest, and having recently enjoyed the hospitality of many members of the Malay Forest Service seeing examples of the successful regeneration work they have accomplished in their evergreen forests, I am taking it upon myself to proffer this apology and at the same time to record something of the impressions gained from a recent all too brief visit to the Malayan forests.

C

Mr. Watson lists 21 titles of papers bearing on the subject of the regeneration of tropical evergreen forest and published in the *Malayan Forester*, written since Blanford's visit (*vide Indian Forester* 1929. pp. 333-9 and 383-95), 13 of them having appeared before the date of our conference, but apparently ignored by the conference. In my paper circulated before the conference, I summarised Blanford's article (Proceedings of the 4th Sylvicultural Conference, p. 144), without referring to subsequent developments. This lapse can only be ascribed to the extremely hurried preparations which had to be made for the conference which it was only decided at the eleventh hour to convene. I can, however, say that the *Malayan Forester* has not altogether gone unnoticed in India, for in the course of one of my tours in 1933, I found a Provincial Sylviculturist carrying an issue around with him in the forest checking up his own experiments against an account given of some similar work in Malaya. Further, I have just called for the *Malayan Forester* from the Institute library and I find that one-third of the numbers are out with different members of the staff. I hope we shall not again give our neighbours in Malaya occasion to think that we are so obsessed with an elder brother's self-sufficiency as to fail to profit from the help they can give us from their experience, and to express our recognition of its value.

Our lapse has at least had one good result in causing Mr. Watson to survey the results obtained so far in the regeneration of the Malayan tropical rain forests. He adopts a method which is most useful for us in India by considering how far Blanford's summary requires modification in the light of further experience.

The first point of the summary was that "the overwood of valuable timber trees should not be felled until the fellings in the underwood have induced regeneration." This requires amendment, as fellings in the underwood do not *induce* regeneration though they may assist it, and also as some felling of the valuable trees may be desirable even at the outset to provide suitable light conditions for regeneration and to minimise felling damage to it.

The second point was that the canopy must not be opened

too rapidly as regeneration requires considerable protection during the period of establishment. It is now clear that the best procedure in this respect depends on species and other conditions, so that operations can be speeded up much more than was thought a few years ago.

The third point was that final felling of the now isolated seed-bearers should not be delayed and is allowed to stand, but Blanford's account of procedure and costs require modification for areas with small demand for lower class materials and has been a good deal affected by the extended use of poison girdling. Reference must be made to the various papers referred to by Watson for detailed accounts and I will pass on to the features which struck me, looking at the areas visited primarily from the Indian point of view.

Firstly, and chiefly, I was struck with the great difference between the forest themselves and all the wet tropical evergreen I have seen in India—I have not visited Tenasserim which I imagine to provide a transition. This difference lies primarily in the predominance of the *Dipterocarps*, not *Dipterocarpus* spp. as we not rarely encounter them in India, but largely *Shorea* spp.—no end of spp.—with several other genera. Except perhaps where *S. assamica* grows, we in India think of *Shorea* as exemplified by *S. robusta* and *S. obtusa*, slow growing hardwoods with rare seedling years and an exceptionally prolonged and difficult establishment stage. In Malaya one soon acquires a very different idea. True there are hardwood species providing durable construction woods (*e. g.*, *S. glauca*), especially in the hills, but softwood species such as *meranti tambagu*, *S. leprosula*, are much more conspicuous in the plains. Now these *Shoreas* (with some exceptions) are capable of regenerating *en masse*, and given a reasonable amount of light will shoot up with an inherently good stem (straight and clean), at a rate which is only attained by our weed species. In other words, speaking comparatively, these *Shoreas* take the place of our Indian weed-species and provide that great desideratum of three-quarters of India, the naturally clean and straight quick-growing softwood. Of course, useless weed-species such as *Macaranga* do occur, but are easily dealt with in

cleaning operations. I was also astonished at the relative scarcity of climbers. *Eupatorium* and *Mikania* have invaded the northern parts of the peninsula and are spreading southwards ; they constitute a risk which must be watched with some anxiety, but so far have not proved so serious as in India and Ceylon.

My field notes on one area, Merlimau in Malacca, will serve as a sample : " In general, a preliminary timber felling has first been done followed by a cleaning and girdling (C. G. 1), repeated as C. G. 2 and C. G. 3 at about 3-year intervals, operations finishing with a final felling removing all trees over 6′ girth. C. 3 carried about $1\frac{1}{2}$ trees over 20″ diameter per acre 2/3 saleable, 1/3 *meranti*, for the 'final' felling. The plan calls for a cleaning and thinning in 10 years time and timber fellings should again be possible in 20-25 years time, *meranti* growing rapidly and the stock of poles being good. The three C. G. operations have cost anything up to $20 per acre, but a good deal of unnecessary work has been done and poisoning is replacing expensive girdling so that Rs. 5/4/-, 3/8/- and 1/2/-, respectively, are budgetted, and Rs. 3/8/-, 2/10/- and -/12/- likely to suffice. There is no trouble with quick-growing weeds or climbers though they are present, and the present tendency is to condense the time table, in fact with *meranti* seeding copiously and frequently, and outgrowing all competitors, the heaviest fellings do no apparent harm. Only excessive shade will kill out the seedling regeneration. Masses of regeneration in all stages are to be seen. Locally, fuel fellings for rubber factories or P. W. D. replace poison girdling (C. 8)."

In another forest there, Bukit Senggeh, it was expected to finish all operations in 4-5 years for Rs. 7/- per acre.

In some areas seen (parts of Kuala Pilah in Negri Sembilan State) in which *Shorea curtisii* predominated, the opening up appeared very heavy indeed where the overwood had been mostly of unsaleable species, and all saplings are retained so that the soil cover was quite adequate and confidence is placed in the *meranti* to push through. Parts of Seremban in the same State were similar, but even in a plot clear-felled three years after a departmental felling of all inferior species up to three feet girth, the *meranti* (which had seeded

well the previous season) was well up, and looked likely to need only one more cleaning.

The fully recorded Research Institute experimental plots described by A. B. Walton in the *Malayan Forester* 1934, p. 29, are very interesting ; the results to date tend to confirm the general experience that *meranti* regenerates very copiously in some years and thanks to its rapid growth, can be quickly and cheaply established if the overwood is lightened and removed in the following few years, the middle and lower canopies check survival and development more than the top canopy, and the regeneration is lost in a few years if it is not given light.

I should mention that in India, I have never seen young evergreen regeneration to compare with this *meranti* regeneration except for rare groups of *Hopea* and *Dipterocarpus* ; in quantity it is like *Shorea robusta* at the end of the rains after a good seed year, *but it responds better than all competitors* to the usual operations for giving it light and air.

The extensive use of sodium arsenite for poisoning unwanted trees where there is no local demand for low class timber or fuel requires mention in view of the mostly disappointing reports of its use from various parts of India. There is no question that in the wet tropical evergreen type of forest it can be most effective and should be fully utilised there. Mr. Strugnell's article on the subject was reproduced in the *Indian Forester* for October 1935. The poison is applied from a sort of tea-pot or oil-can to a frill of quite shallow axe cuts (a *dah* or *khukri* would serve equally well). The usual strength of solution is 1 lb. to one gallon of water sufficing for one acre, but weaker solutions are quite effective though slower. It struck me in some places that these poisoning operations seemed to have swept through an area rather too mechanically. Often the operation was referred to as (Oliphant's) " Key tree poisoning," but there didn't appear to be much key tree about it—in fact there seemed to be some justification for the concluding paras. of the editorial on p. 2 of the recent issue of the *Malayan Forester* including our indictment.

But that is only a matter of minor adjustment in a relatively new field.

One doubt which came into mind while seeing and discussing this excellent regeneration work was whether a sufficiently long view was being taken. It is one thing to avoid the evils of over-rigid working plans, but another to look no further ahead than a regeneration period. I did not see the working plans and so would not be justified in commenting on them ; and probably there were blocks of forest suitable in all respects for carrying on if there is a hiatus on completion in the blocks under regeneration, but the doubt occurred to me. In India, too, we have to bear in mind that whereas we usually deal with residual blocks of forest in a generally settled and cleared country, in much of Malaya there is more forest than needed, quite a lot of it on land which would have been cleared centuries ago in India. It is also evident that results and procedure will have to be varied appreciably in the different parts of the peninsula.

I could wish I had been able to come away from Malaya convinced that they had found a solution for our Indian difficulties in regenerating the tropical evergreen forest. I was not able to do so, because they are dealing with a different type of forest, true evergreen Dipterocarp forest in which the species which regenerate most freely and respond best to improved light and space are desirable ones from the point of management not useless species and climbers as with us. We can learn a lot from their work, but we cannot apply their methods with any great prospect of success.

In conclusion, I would strongly recommend regular perusal of the quarterly *Malayan Forester* to foresters throughout India, above all to those concerned with wet tropical evergreen forest. The current issue (January 1936) includes several articles of considerable interest to us, among which that by J. S. Smith on measurements of light-intensity under a canopy may be specifically mentioned.

A NEW GENUS OF THE CONNARACEAE

By C. E. Parkinson

Forest Botanist, F. R. I., Dehra Dun

Schellenbergia C. E. Parkinson, genus novum. Flores hermaphroditi, pentacycli, heteromeri. Sepala 5, imbricata. Petala 5, calyci longiora, glabra. Stamina 10, episepalia epipetaliis longiora, filamentis basi vix conjunctis, glabris; antheræ dorsifixæ, longitudinaliter introrsum dehiscentes. Carpellum solitarium, villosum, stylo villoso auctum; stigma subdisciforme; ovula in loculo bina, collateralia, anatropa, erecta, in media longitudine suturæ ventralis affixa, uno abortivo. Calyx fructifer haud accretus. Folliculus cylindrico-falcatus, graciliter stipitatus, in stipitem erectus, rostrato-acuminatus; extus intusque glaber; pericarpium coriaceum, endocarpio sclerenchymatico maturitate ab exocarpio soluto, sed sutura dorsali eo tandem affixo. Semen unicum, testa atra, pseudobaccata, basin versus in arillum tunicatum, undulatum, basi ipse in appendiculum longum, filiforme, in stipite folliculi inclusum producta, itaque semen appendiculce folliculo aperto dependens; hilum laterale, sphenoideum; radicula supera; endospermium rudimentarium, circa radiculam copiosius, cellulis albumen gerentibus; cotyledones crassæ, albumen et oleum gerentes.—Arbor parva vel fruticosus. Folia unifoliolata, foliolo integro. Inflorescentiæ axillares, subracemosæ, foliis iuvenilibus coætaneæ.

Typus: Schellenbergia sterculiæfolia (Prain) Parkinson in herb. Kew.

Spec. 1, Birmæ inferiores incola.

Dr. Gustav Schellenberg, monographo Connaracearum, dedicata.

Schellenbergia sterculiæfolia (Prain) Parkinson.

Ellipanthus sterculiæfolius Prain in Journ. As. Soc. Beng. LIX, 2 (1890), p. 209, t. 8. Arbor vel arbuscula 4-6 m. alta. Folii rachis 2·5—4·5 cm. longa, gracilis, glabra; foliolum 8-12 cm. longum, 3·5—5·5 cm. latum, ovatum, apice longius acuteque acuminatum, basi rotundatum, chartaceum, adultum glabrum, iuventute sub-

ferrugineo-sericeum, supra olivaceum, subtus glaucescens ; costæ secundariæ utrinque 5-7, tenues, arcuatæ, lamina inter costalis dense areolata. Inflorescentiæ axillares, rachibus foliis iuvenilibus subæquilongis, sericeis. Flores albi, fragrantes ; sepala 2·5 mm. longa, vix 2 mm. lata, ovata, extus villosula, intus glabra ; petala 5·5 mm. longa, 2 mm. lata, liguliformia, glabra ; staminum filamenta glabra ; ovarium villosum. Folliculus stipite gracili 7 mm. longo incluso 3 cm. longus, 1 cm. crassus, cylindrico-falcatus, rubellus, apice rostrato-acuminatus, rostro 6 mm. longo ; pericarpium glabrum, nervis exsculptis laxe reticulatum. Semen 1·4 cm. longum, 0·8 cm. crassum, basi arillo luteo 4 mm. alto ornatum, appendiculo arilli 1 cm. auctum.

Distrib.—Lower Burma, South Arakan, Bassein district. In shrubbery of the sublittoral forests of Diamond Island and near Pyinmadon village in the Thabaung township.

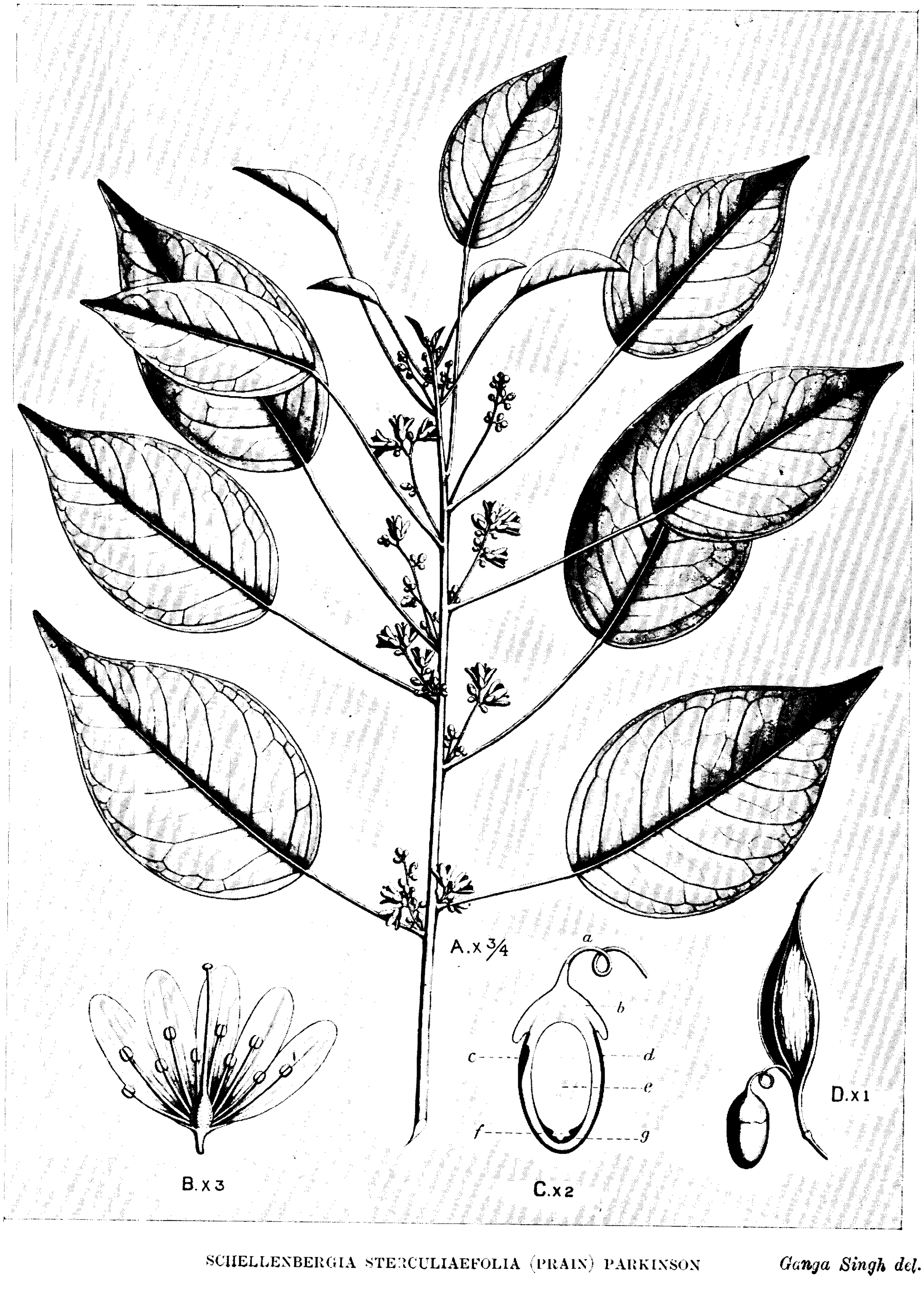
Herbarium specimens seen—D. Prain, Diamond Island, 21 November 1889, fruiting (typus in herb. Kew).

C. E. Parkinson No. 8729, near Pyinmadon, Bassein district, 29 December 1928, fruiting.

Range Officer, Pyinmadon, Thabaung, Bassein district, March 1933, flowering.

Schellenbergia sterculiæfolia, as seen by the writer, is a deciduous shrub attaining a height of 2 to 3 feet. Its leaves turn yellow and red before they are shed about the month of January at which time the fruits also ripen. Flowering takes place in March. The ripe fruits are peculiar ; the reddish pericarp splits down the side and from the base of this fissure the single black seed with reddish aril hangs by a long funicular-like appendicule.

The plant was first discovered in fruit by Prain in 1889 on Diamond Island off Cape Negrais. The writer found the plant growing commonly among shrubbery near the village of Pyinmadon in December 1928, and fruiting specimens were obtained. Flowering specimens were obtained through the Divisional Forest Officer, Bassein, in March 1933. The flowers are white and fragrant. The Burmese name for the plant is *Kyetphe*.



SCHELLENBERGIA STERCULIAEFOLIA (PRAIN) PARKINSON *Ganga Singh del.*

Prain described the plant in the genus *Ellipanthus* but found it necessary to modify slightly the description of that genus in order to admit it. An examination of the specimens show that the plant differs from the other known species of *Ellipanthus* not only in having a bare fruiting carpel but also in having 10 fertile stamens. Normally 5 petals and 10 stamens are present, but occasionally 6 petals and as many as 12 or 13 stamens occur, the filaments of 2 stamens being sometimes joined. A new genus with the name *Schellenbergia* is therefore proposed. The name is given in honour of Dr. Gustav Schellenberg, the monographer of the Connaraceæ, to whom the writer is indebted for a note and opinion on the systematic position of the plant.

Plate 23.—A, Flowering twig x$\frac{3}{4}$. B, Flower opened to show stamens and ovary x3. C, Seed x2 showing *a*, appendicle of arillus; *b*, arillus; *c*, hilum; *d*, testa; *e*, cotyledon; *f*, radicle; *g*, endosperum. D, Mature fruit with seed x1.

REVIEWS

AN OUTLINE OF GENERAL FORESTRY

BY JOSEPH S. ILLICK.

(*Pp. 259 Illustrated. Barnes and Noble, New York.*)

At the moment, for a reason which will be dealt with at the end of this review, we are more than ordinarily interested in the forestry text-books of other countries, not only for the subject matter they contain, but also for the method of its presentation.

We have received for review " An Outline of General Forestry," by Joseph S. Illick, Professor of Forest Management at Syracuse University. We fancy that this useful little book will be treated with the more respect by foresters in America because of the author's administrative experience as former State Forester of Pennsylvania.

The title of the book may be somewhat misleading, but it is difficult to think of a more appropriate one. Perhaps " A General Introduction to Forestry in the United States " would be better. It does not pretend to deal scientifically or in great detail with any particular branch of forestry, but forest history, administration, management, policy, education, utilisation and forest protection in the United States are all touched upon. To the forest student it is an interesting gateway to the more specialised fields of forestry science, and to the layman it is a simple guide to a better understanding of the forestry activities of his country.

The subject matter is of no particular interest to foresters in India, but the method of its presentation should give ideas to anyone responsible for forestry instruction. The book contains far too many figures for our liking, but they are illustrated by diagrams rather after the style sometimes adopted by two of our leading London illustrated weeklies. Clever use is made of section and paragraph headings in different type from the text. Long paragraphs are avoided and information is tabulated wherever suitable. At the end of each chapter questions are given followed by a list of selected references to literature on the particular subjects dealt with in the chapter. Finally, but a point which is of some importance in a text-book, the book is well printed on good paper, and hasn't the drab,

shoddy, unattractive appearance that characterises so many of our Government publications.

I would like to take this opportunity of alluding briefly to India's position regarding text-books.

In his address at the opening of the Forest College, Dehra Dun, last April, the Inspector-General of Forests stated: "I can tell you that the forestry we have developed in India is the equal of that of any country in the world." In one respect, however, we are still lagging behind other forest countries, and that is in the production of suitable forestry text-books for the training of our students.

The policy of most provincial governments appears to favour having a single gazetted service. With the adoption of a single gazetted service for the two existing gazetted services, it appears to me that the importance of the forest ranger class of officer will in the future be even greater than it is at present. Following the traditions of other British services, I see no reason why outstanding forest rangers should not continue to expect promotion to the gazetted ranks. If we are to maintain the efficiency of our forest administration, and if our forestry technique continues to develop its own national characteristics as it is doing at present, we must endeavour to maintain and, if possible, to improve on the past high standard of training of our forest rangers.

Moreover, it seems to be almost certain that the training of future probationers for the gazetted ranks of the service will be carried out in India. India has provided in the Forest Research Institute probably the largest and one of the best equipped institutions of its kind in the world. It is provided with a large staff including experts in almost every branch of forestry science. We have at its doors forests containing areas illustrative of scientific management as instructive as almost anything in Europe. In Indian forestry, forest engineering is only second in importance to forestry proper. The training in forest engineering given at Dehra Dun in the past has been incomparably better than that given to I. F. S. officers in the forest schools of Great Britain. Political India, I think, would be justified in expecting us to train our own gazetted staff.

At the moment we have no class of probationers under training for the gazetted ranks of the service. Under the new constitution, forestry will be a provincial subject and the training and appointment of its forestry officers will be matters which the provinces will have power to decide entirely for themselves. But I have no doubt that the Central Government will continue to make the present facilities at Dehra Dun available to the Provinces and Indian States, and that the Provinces and States will continue to avail themselves of these facilities. Already in some provinces, no direct appointment has been made to the I. F. S. for six years. Unless direct recruitment from amongst students trained in Europe is made, in three years' time the most junior officer in the service in some provinces will have nine years' service. This will result in a shortage of experienced senior officers in 20 years' time which no administration can regard with equanimity however much over-staffed they are at the present time. It appears to me to be essential to resume the training of our gazetted staff in the very near future. The temporary closure of the Forest College for the training of our forest rangers and gazetted staff has shown that it adds to the difficulties of training in many ways. Had it not been for this unfortunate lack of continuity, it is probable that the present position regarding up-to-date text-books on Indian Forestry would have been repaired.

There is one other reason which makes it imperative that we should have our own forestry text-books. In India we have already developed to a very large extent our own forestry technique, which is quite different from that practised in Europe. To teach or to learn Indian forestry to-day it is quite useless to rely on the text-books that were written for and illustrated from the conditions prevailing in Europe. I am not even certain that Indian forestry text-books should follow the general lines adopted by European text-books. That may still be advisable, but it is certainly not essential.

The necessity for having our own text-books is all the more evident when our system of training in this country is considered. It is rare for any officer to be in charge of the instruction for more than three years. We are not lacking in literature as the innumerable

solutions of the *sal* regeneration problem alone can testify. But to give a lecture on almost any subject of Indian forestry, it is usually necessary to hunt out references from at least half a dozen different sources. I do not contend that any series of text-books are by themselves sufficient for instructional purposes, but there can be no question that the existence of a text-book saves time and labour on the part of both student and instructor.

With the possible exception of forest engineering we have no up-to-date *text-books* on any Indian forestry subject. The "Manual of Forest Engineering for India," by C. G. Rogers, I.F.S., could scarcely be improved on as a text-book, but it was published in 1899 and is now somewhat out of date. Useful notes on the same subject, concise and up-to-date, were compiled by D. Davis in 1933.

We have a large number of excellent publications dealing with particular problems of sylviculture and management, but the only *text-book* on Indian sylviculture is Troup's manual published in 1906 and revised in 1910. So great has been the advance in our general forestry technique, in the compilation of yield and volume tables and in the recording of our forestry knowledge during the last 30 years, that the manual of Indian Sylviculture is either out of date or inadequate in its treatment and presentation of the subject. It would be quite impossible to write to-day a text-book on Indian Sylviculture and Management, and to deal with it adequately in one small volume.

In any series of text-books on Indian forestry such as I think are required, an introductory volume somewhat on the lines of Professor Illick's book which I have reviewed above might well, I think, find a place."

W. T. HALL.

NOTE BY I. G. F. ON TEXT-BOOKS ON FORESTRY IN INDIA.

As regards Mr. Hall's complaint about text-books on Indian Forestry we are glad to be able to inform our readers that a comprehensive manual of Forest Utilization by Capt. H. Trotter, the Forest Economist at the F. R. I., will shortly be published by the Oxford University Press. This book has been seen by practical foresters in different parts of India and every effort has been made

to make it of real use to all ranks of the service. In the case of Sylviculture, a book on this subject has been contemplated for the past year.

Part II, Indian Sylvicultural systems has been completed by Mr. Trevor, and Mr. Champion is now preparing *Part I, Indian Sylviculture.* This book will also be published by the Oxford University Press and so the complaint against the style and get-up of Government publications has been removed. We would remind our readers that it is useless for authors to devote their time to such work unless members of the service take the trouble to make themselves acquainted with the contents. Readers will, we feel sure, find much information in these books which are nowhere else available and no forester who wishes to have a competent knowledge of his profession can afford to be without this up-to-date work on Indian Silviculture and Indian Sylvicultural Systems, some of which are quite different from anything in text-books on temperate forestry.

PROGRESS REPORT ON FOREST ADMINISTRATION IN THE UNITED PROVINCES FOR 1934-35

The outstanding features of the financial working of the United Provinces forests in 1934-35 were : (*a*) recovery of the surplus, which rose by nearly Rs. 3 lakhs to Rs. 22,26,746, the highest figure since 1929-30 ; and (*b*) still more extreme financial stringency, resulting in postponement of the construction of badly needed roads in the hill forests ; in deterioration of buildings for want of adequate repairs ; in bad housing of subordinates ; in postponement of essential repairs to boundaries ; in excessive retrenchment of expenditure on fire-protection, in restriction of operations for the tending of the growing stock, and in the suspension for the fifth year in succession of the forest training classes. Afforestation in the ravine tracts, too, is nowadays entirely held up for lack of funds, although there is some pressure of public opinion in favour of a revival of this branch of the department's activities.

It is not surprising that the Chief Conservator has had to sound a note of warning that for future expansion of revenue the reinvestment in the forest estate of a larger share of the present surplus is essential. The United Provinces Government's resolution on the report shews that they too are well aware that it is essential, but that they have no intention of doing anything about it yet. In fact, they paint the future in gloomier hues. "The Governor, in Council," we read, "is well aware that any substantial increase in forest wealth, and, in parts of the hills, even the continued conservation of existing forests, require capital outlay in the first instance. Existing financial considerations make such a policy at present impossible."

That ominous remark about the continued conservation of existing forests in the hills, refers apparently to the 1,900 square miles of unremunerative Class I oak and miscellaneous forests in Kumaon and Garhwal, where forest control has since 1921, been only nominal. Of these forests we read that the boundaries were inspected by the Forest Department and estimates for their repairs drawn up. "Already over Rs. 13,000 is required for urgent repairs, but it has not yet been possible to provide funds. If the repairs are not carried out very soon the demarcation will be lost." One may venture to express the hope that this expenditure, amounting to about 2 pies an acre, will not after all prove to be wholly beyond the resources of a Province which has hitherto notified and maintained its forest boundaries with exemplary care ; a Province moreover which, even during the slump years from 1929-30 to 1934-35, has enjoyed an enviable surplus of forest revenue over forest expenditure amounting on the average to well over 20 lakhs per annum.

To turn to more cheerful things. Natural seedling regeneration of *sal* continued to be the most important sylvicultural problem. Experiments are progressing favourably, and a leaflet may be issued shortly. It was a good year for *chir* regeneration, although establishment of complete regeneration to the extent required in the *chir* forests is still hindered by periodic forest fires. *Taungya* was further extended by 2,704 acres, mainly in Gorakhpur, Gonda and Saharanpur forest divisions.

Annual Form No. 11 is not printed with the Report, but it is evident that progress in working plan revision goes on steadily. During the year the Chief Conservator's sanction was accorded to revised working plans for 1,630 square miles; and at the close of the year revision was in progress over a further 1,541 square miles. Little or no difficulty was found in working up to working plan prescriptions. It is indeed rather remarkable that, notwithstanding the somewhat depressed economic conditions, practically all the forest produce the department had for sale was sold at quite good prices.

As in other parts of India, the Forest Department supplied free of charge to right-holders, concessionists and free grantees a great quantity of forest produce (valued at over Rs. 6 lakhs), for which no credit is shewn in the department's financial returns.

For many years past the United Provinces Forest Department have generally maintained happy relations with their best customer, the Railways; and, inspite of the fact that the utilization branch of the forest administration has for some years past been in abeyance, the Railways are evidently well satisfied with the arrangements made in 1934-35. *Sal* and *chir* sleepers, 303,179 metre-gauge and 100,441 broad-gauge, respectively, were supplied through the Forest Department to the Tarai and Northern Sleeper Groups. The Northern Sleeper Group gave a fresh three-year order at slightly higher rates for *chir* sleepers, and the Tarai Sleeper Group are relying more and more on the passing of sleepers by Forest Officers for the whole of their sleeper requirements.

Resin, as usual, was exploited by departmental agency. The Turpentine and Rosin factory were supplied with 109,586 maunds and, the weather being very favourable for resin flow, all previous records of rate of outturn were beaten with a yield of 8·03 maunds a hundred channels. The net increase in the surplus of the Kumaon Circle from this industry was over Rs. 50,000.

In the Eastern Circle an increase in sales of about 9 lakhs of c.ft. of firewood is attributed to the demands of sugar factories, which have greatly increased in number in that part of the United Provinces during recent years.

An interesting, though as yet very small, new development was the sale of a little over 100 maunds of lac from the Jhansi forest division. Jhansi division has not hitherto been regarded as a source of lac supply, although lac has for many years been exploited by the Central Provinces Forest Department right upto the boundary of the Jhansi forests.

The United Provinces National Parks Act, 1935, has become law, and an area in Kalagarh and Ramnagar forest divisions has now been constituted a national park and sanctuary for the preservation of wild life. Thirty square miles of forest in Dehra Dun division, too, have been declared a sanctuary. During 1934-35, 101 tiger and 1,359 other animals were reported to have been shot in the Government forests of the United Provinces.

The Chief Conservator pays a tribute to the good work of the Kumaon Forest Advisory Committee during the ten years of its existence, and to its helpful influence in establishing good relations with the people of the Kumaon and Garhwal hills and in supporting the interests of forestry there. The gravest problem of the moment there is to find a way of saving from final destruction about 32,000 acres of oak forest, in the Class I reserves, which have now been inspected and reported to be so badly damaged that the trees are dying. The Advisory Committee have recommended that, in the first instance attempts be made to bring the damaged forests under *panchayat* management. There can be little doubt that in the active co-operation of the local people lies the only possible permanent solution: and the panchayat forest movement continues to make steady progress in these hill districts. It seems to be a really promising attempt to solve what has become one of the most pressing problems of rural reconstruction in many parts of India. But its progress, as is only natural, is not yet very rapid, and it is very doubtful whether it can be used to cope with the progressive deterioration of many of the most seriously damaged oak forests in time to save them.

Altogether a most interesting report of the year's work on a very valuable estate!

THE FAUNA OF BRITISH INDIA : GROUND-BEETLES.

COLEOPTERA. CARABIDÆ. VOL. II—HARPALINÆ—I

BY H. E. ANDREWES.

(*The Fauna of British India*, 1935, *pp. i—xvi*, 1—323, *figs.* 51, *plates V*, *map.* 1.)

In the *Indian Forester* for November 1931, we reviewed Mr. H. E. Andrewes' first volume on the Carabidæ or Ground Beetles of India. Six years' additional work has produced a further instalment on this large family of beetles, dealing with the sub-family Harpalinæ. It provides descriptions and synoptic keys for twenty-five genera and two hundred and fifty-two species : There are fifty-one text-figures and five plates (four coloured) that illustrate most attractively a further forty-five species. There is also a folding map of the region and a glossary of technical terms.

We remarked in the previous review that this series of monographs, issued under the general title of the *Fauna of British India*, is gradually reducing the obstacles that stand in the way of collectors of insects in this country, but we fail to note any newcomers among the collectors who have supplied the material on which the book is based.

With the aid of the admirable analytical treatment to be found in Mr. Andrewes' two volumes the collection and study of the Carabidæ can now be taken up with interest and profit.

C.F.C.B.

ADMINISTRATION REPORT OF THE BOMBAY PRESIDENCY FOR 1934-35

Financial Results.—The financial results of the year were satisfactory. The surplus shows there was an increase of Rs. 2,74,589 and Rs. 2,70,261, as compared with the previous year and the average of the previous quinquennium.

The increase in surplus is due in part to the slight increase in prices of timber, but also to decrease in expenditure. The department is obviously still striving to increase revenue and curtail expenditure to obtain money to increase the general revenues of the Presidency.

With the prices of timber almost stationary there is not much scope for spectacular results, but the figures show that the department is succeeding in so far as it lies within their power.

Plantation.—The area of forest converted to plantations continues to increase. In all circles large areas are planted up each year so that with each succeeding year, works of tending, cleaning and thinning to be got through, snowballs. It is doubtful whether the staff as at present constituted will be able to cope with it, and if financial results improve it is hoped that the staff may be increased.

Working Plans.—No new working plans were made or taken up during the year. All forests capable of being put under a working plan have been dealt with in the past.

The revision of two very important plans was sanctioned by Government, *viz.*, the Haliyal Teak Pole Working Plan, and the Working Plan of the Nagzari Valley and Kalinadi-Kaneri slopes.

In addition the work of revising nine other plans—three very important ones and six minor ones—was in hand during the year.

It appears that everything possible is being done to keep this very important branch of the department's work up to date.

General Administration.—In no instance has any complaint by the public against the administration of the department been mentioned in the Report. This shows that a very satisfactory state of affairs exists.

In conclusion it may be stated that the year was one of steady achievement by the department without any untoward happening and with slightly improved financial results. More than this cannot be hoped for in the days of low prices and scarce money.

EXTRACTS

SALT TOLERANCE OF PLANTS AS INDUCED BY PRE-TREATMENT OF SEEDS

The Homeopathic system of therapeutics rests on two main principles: (1) that 'like be cured by likes,' and (2) that the remedies be administered usually in minute doses. The latter fact has a close parallel in the agricultural practice of fertilisers, where the dosages of the active ingredients added are extremely small as compared to those already present even in the poorer soils. This gave rise to the speculation, if the first principle of Homeopathy that 'like be cured by likes' could in anywise be utilised to serve some necessities of plant life.

As an initial experiment, it was proposed to try the possible application of this principle to the successful production of plants on salt lands. There was a considerable mortality of seedlings in saline soils. May be the plants otherwise healthy,

E

developed certain fatal symptoms due to the presence of certain salt or salts in the soil. Were it so, it was held possible to save them by administering identical salts in minute doses. By the same law, if a plant already affected by the given symptoms be now sown in a saline soil, it is as probable that the salt in the soil will now prove a remedy; in other words, the salt tolerance capacity of the plant will greatly increase.

To test the correctness of these assumptions a series of laboratory experiments were conducted with wheat, *Dolichos lablab*, *Sorghum* and barley. In the first series, only the treatment of seeds was undertaken, while the treatment of seedlings and plants was left over for the second. As the saline soils in Sind contain chiefly the chloride and the sulphate of sodium, experiments were restricted in the present instance to the use of chloride of sodium only.

The method in the main was to first induce the supposed symptoms in healthy seeds, by treating them with NaCl solutions of different homeopathic concentrations (ranging from 0·35 to $\frac{0·35}{10^{18}}$ %). The seeds so treated were sown in sand cultures at 25 per cent. moisture and containing the same salt NaCl in such percentages as are commonly found to be present in the salt lands in Sind. A study of the percentage germination in the different cases was made with the following results:—

Table showing average percentage germination of wheat seeds, treated with salt solutions of different concentrations and sown in sand cultures with and without salt.

In the sand culture.	Seeds untreated.	Seeds pre-treated with water only.	Seeds pre-treated with salt solutions of various minute concentrations.
No salt	100	100	100
NaCl 0·4%	65	80	100
,, 0·5%	40	57	70—90
,, 0·6%	15	20	20—75

In a pure sand culture (without any salt in it) the germination is cent. per cent. whether the seed is treated or not. But once the salt is introduced into the culture, the germination of the seeds is affected, the larger the amounts of salt the lower being the germination.

Now where the seeds were pre-treated with salt solutions and then sown in salt lands, it is seen that for a given salt content in the culture the germination is generally better than in the controls (seed untreated). Also soaking in water alone has given a slight advantage to the seeds in germination.

It has also been found that the percentage figures of germination obtained with seeds treated to successive dilutions and sown in sands with the higher percentages of salt, *viz.*, 0·5 and 0·6% arrange themselves roughly into a parabolic curve when plotted against dilutions, the medial dilutions tried giving about the best results.

It is indeed interesting that the germination of wheat seeds was raised from 40 to 90% in sand with 0·5% salt and from 15 to 75% in sand with 0·6% salt, by the pre-treatment of those seeds with a solution of the same salt as was present in the sand culture, in a given concentration ($\frac{0·35}{10^{10}}$%). Similar results have been obtained in all the repeated trials made to confirm the original results.

Because of the striking consistency and promise of the data the work is being continued in pot culture and on small plot scale. No claim is made that definitely 'like has been cured by likes' but it is suggested that the physiological and biochemical aspects of the phenomenon deserve a systematic inquiry.

V. A. TAMHANE.

M. A. SHAMA IYENGAR.

Chemistry and Soil Physics Department,

Agricultural Research Station, Sakrand.

(*Current Science*, May 1934).

AFFORESTATION AND RAINFALL

In the course of his presidential address to the Botanical Section of the British Association, Professor A. W. Borthwick, Professor of Forestry in the University of Aberdeen, said:

"Although it has not been definitely decided whether forests increase the rainfall or not, it can be claimed with every justification that the forest is of great importance as a conservator of water and as an equalizer in the drainage of the land. Where no forests exist in the upland or collecting regions of watersheds the rain falls unhindered, beating the surface hard or eroding it down to the bare rock. There is nothing to check the downward rush of water, which collects into mountain torrents, which gush unbridled into the main rivers and streams, causing them to become swollen and flooded. These in turn race through the fertile valleys to their outlets, tearing down and overflowing their banks. The damage done by severe and sudden flood to roads, bridges, agricultural crops and stock, including human habitations, is well-nigh incalculable. Nor does the matter end there: millions of tons of valuable soil are washed away in these turbulent floods, and deposited as barriers in the river beds or in the sea at the river bar. Harbours and docks at the outlet of our main rivers become silted up with mud and debris: this in turn—apart from the loss of soil—involves costly dredging operations to keep the navigation channels clear.

"Where forest exists in the upland districts or collecting ground of the water, rivers are more uniform in their flow, year in and year out, and carry much less silt and debris. The crowns of the trees break the force of the falling rain; the humus layer on the forest floor has an enormous water-absorbing capacity, and when saturated it allows the water to percolate slowly into the deeper loosened layers of mineral soil from which in turn it gradually finds its way into springs and watercourses. Further, the influence of the forest is such that the melting of snow is more gradual and water is slowly absorbed and held, thus again avoiding floods. The forest regulates the off-flow of water after heavy rains or melting snow. This water is fed into springs and watercourses more gradually throughout the year, thus preventing floods at one season and equally serious drought at another . . . . I do not claim that afforestation or forest conservation in the high ground and valley slopes will entirely prevent floods and drought, but what the forester is doing, or leaves undone in the remote hinterland will go a long way to check or ameliorate the evil effects of both."

(*Journal of the Royal Society of Arts*, October 12, 1934.)

WIRE ROPES FOR LOGGING

For the hauling of logs, only the highest grade of wire rope must be used if satisfactory results are to be obtained because of the severe conditions, which also applies, it may be stated, to steam ploughing. In this connection great interest attaches to the latest types of special logging ropes manufactured by the Whitecross Co., Ltd., of Warrington, which are extensively used, for example, in the logging camps of Western Canada, the United States and other countries. The steel from which these wire ropes are made is the firm's improved "Plough" brand, used also for ploughing, and even for the one general application of logging they supply a number of varieties of rope according to the conditions, quite apart from ropes for all kinds of purposes, such as mines, lifts, conveyors, aerial ropeways, cranes, oil-wells, wireless equipment, and cable tramways.

One general method of constructing wire ropes for logging, especially according to the McNaughton system, for example, operated largely in Western Canada, is to close six strands each made of 19 "Plough" quality steel wires of equal diameter round a manilla core centre. For unusually heavy logging work, however, what is known as "Seale's" construction is utilised, consisting of six strands made of 9 outer wires of larger diameter, 9 inner smaller diameter wires, and 1 centre wire of larger diameter, that is, 19 wires as before, but different in arrangement and diameter, here also being closed round a manilla core. In addition the strands have two layers of wires round a centre; the outer and inner layers consist of the same number of wires, and the outer ones lie in the grooves between the inner ones, while all the wires also are laid up in one operation. Consequently, they are in line contact throughout and no internal cross-cutting can take place. If special flexibility is required, the ropes, according to either of the above methods are made of eight strands, each of 19 wires, instead of six strands, with the usual manilla core.

The process of wire and wire rope manufacture has been greatly improved during recent years, largely because of the more scientific methods adopted. In general the basic principle is to start with steel billets which are heated and then rolled down in a succession of rolling presses to long rods of much smaller cross-sectional area than the original billet. These rods are then specially heat treated, a process known as "patenting," to produce a suitable physical condition to allow of drawing down to smaller sizes followed by cleaning or pickling in dilute acid and then cold drawing into wire. This is carried out by drawing the rods with great force through a series of cast-steel on alloy dies, having a hole or aperture so that the drawn wire is the exact cross-section required. The wires so obtained are then stranded or twisted in special machines to form strands having any desired number of wires, and a number of these strands are then closed into the final rope.

(*Capital*, 4th July 1935.)

HOW LIGHTNING PRODUCES THUNDER

It is now thought that the sound of thunder is caused largely, if not entirely, by a sudden increase of pressure due to heating, dissociation, and ionization along the path of a lightning stroke, says Mr. M. G. Lloyd, Chief, Safety Standards, writing in *The United States Daily*.

The energy of a stroke may amount to 10·8 or 10·9 watt-seconds, of which the greater portion is expended in heating the air. If the path is assumed to be a foot in diameter and a mile long, 10·8 watt-seconds would heat it to about 650 degrees centigrade, with an increase of pressure of about two atmospheres. The dissociation would add to this by increasing the number of gas molecules.

This increase of pressure, which may, in reality, be much greater than two atmospheres, takes place very abruptly and is sufficient to account for the ear-splitting crash which accompanies a near-by flash of lightning.

(*Scientific American*, May 1934).

INDIAN FORESTER

JUNE, 1936

A NOTE ON REGENERATION IN THE DEHRA DUN FORESTS

By W. A. Bailey, I. F. S.

The *sal* forests of Dehra Dun form the western limit of commercially exploitable *sal*, and are, generally speaking, not of particularly good quality. It is also recorded that at the time of reservation (1879) the *sal* forests in the Dun had been almost entirely destroyed. In spite of this it is particularly noticeable that over large areas there is a considerable quantity of regeneration. There are extensive areas covered with pole and sapling crops which undoubtedly date back to the early days of successful fire-protection. With the exception of Professor Troup's plan for the Thano forests no organized attempt was made to set free or utilize this regeneration until Mr. Bhola's plan of 1923-24 came into operation. Under Professor Troup's plan the existing small pole and sapling crop, where suitable, was kept as the future crop and elsewhere defective advance growth was cut back. This has produced excellent results over certain areas, noticeably in Ramnagar Compartments 1 and 2 where final fellings were made in 1926-27.

In Mr. Bhola's plan the general treatment prescribed for the *sal* forests was conversion to uniform high forest with regeneration by compartments under a shelterwood.

The plan was first started with a rotation of 120 years and six periods. Finally, however, P. B. VI, in which reproduction was considerably advanced, was combined with P. B. I to form the regeneration area and the conversion period was reduced to 96 years with three periods. It must be remembered that this plan was made at a time when conversion to uniform was the popular form of management for *sal* forests in the U. P. Also there was a belief, held at least by a considerable number of officers, that heavy fellings

A

were necessary over young *sal* regeneration. Parenthetically it may be stated that this note makes no attempt to go into the question of the calculation of the yield, the allotment of areas to this uniform working circle, and like matters, but merely deals with the methods adopted to obtain new regeneration and to utilize what already existed.

The following quotation from the plan makes clear the ideas that then existed: "With a somewhat heavy opening of the canopy seedlings already on the ground improve greatly, stop dying back and start to grow up." There is a word of warning that this "is not yet absolutely proved, but all the silvicultural experiments tend to show that this is so." Unfortunately experience has shown that this is not so. Put briefly the regeneration fellings were to be made—

(1) to utilize the existing regeneration where good by removing the overwood;

(2) to obtain regeneration by coppice where the existing regeneration was unsuitable for retention, and over this to keep 20 to 25 well grown trees per acre for shelter and seed;

(3) to make seeding fellings where regeneration did not exist.

The idea was that in P. B. VI the pole and sapling crop would be good enough to keep as it was, whereas in P. B. I., although there was adequate regeneration over large areas, it would have to be cut back. It is stated in the plan that "a great deal of the new regeneration will consist of coppice from the great quantity of suppressed advance growth already existing." It was laid down that "groups of well grown saplings and poles of not more than 8″ diameter and covering an area of not less than one square chain should be reserved to form part of the future crop." It was not permitted to keep isolated poles.

The way the plan was put into operation during the first few years was roughly that 20 to 25 well grown *sal* trees per acre were reserved and the contractor who purchased the lot was allowed to fell everything else down to 8″ diameter. In the year after the

felling, cultural operations were carried out to cut back unsuitable growth and to retain as the future crop what came up to the standard above mentioned, *i.e.*, well grown groups of saplings and poles up to 8″ diameter, not less than one square chain in area. It was soon found that over very large areas, even in P. B. VI, the growth below 8″ was unsuitable for retention. Most of it was misshapen, badly damaged in various ways, irregular, and would only have produced an irregular crop of unsound trees at maturity which was definitely not the object aimed at. Accordingly, over very large areas, trees over 8″ diameter were felled as overwood and the great majority of the sapling crop up to 8″ diameter was cut back. A careful examination of the smaller pole and sapling crops showed that most of this was so defective that they would never produce sound trees at maturity. Those of us who studied forestry at Salmünster, under Forstmeister Hebel, may remember being taught that unsoundness in trees is almost invariably caused by damage to the tree in its early youth. The more one sees of *sal* the more does the truth of this come home. In old mature trees rot is often found in the central portions. This may have spread down from a frost-damaged top, but more often than not it undoubtedly dates back to the time when the tree was a sapling or small pole. It is my considered opinion that the majority of the small-sized crop in Dehra Dun is not suitable for retention unless we want to grow up a crop of useless unsound trees. In poor areas and places liable to severe frost damage it is another question, and anything that has grown up, unsound or not, may have to be kept. Incidentally it may be mentioned, that more groups of saplings and small poles were kept than is realized. In many areas it is found that the coppice crop has grown up so well around them and merged in with them, that the Range Officers cannot now recognize what are saplings and small poles retained from coppice obtained from the cutting back.

It is interesting to note the words " and for seed " at the end of (2) quoted above. It was believed that by keeping 20 to 25 good *sal* trees per acre where the existing regeneration was absent or

deficient, fresh seedling growth would be obtained that would be speedily established and grow up. This also unfortunately did not materialize. After a few years slight alterations were made in the marking rules for regeneration fellings, the chief difference being that miscellaneous species were preferred to *sal* for shelter trees where required, and *light* seeding fellings would be made where new regeneration was required.

The result of these operations was to grow up an excellent sapling crop over very large areas. Where the regeneration was inadequate, the seeding fellings made, whether heavy as at first or light as later, have failed to produce the desired results. This, however, concerns very trifling areas, and eventually probably regeneration will be obtained. Mr. Bhola's plan made no sub-compartments; so many areas were included which were unsuitable. Work was generally done more or less all over a compartment, so frosty areas with frost-bitten *sal* in them were sometimes included in the regeneration areas. Such areas can be found in Koelpura, Malhan and Gola Tappar blocks. These are now called "failed P. Bs. I," but really they are no worse now than they were before, and are not the result of fellings made under the plan. The badly frost-damaged areas of Malhan are mentioned in the older working plan. These are comparable with the frosty *chandars* of Pilibhit and South Kheri. The sapling crop did excellently until it received its first set-back from frost in 1925-26. A considerable area was then damaged by frost, it being found that the shelter trees retained were inadequate to protect the young crop from frost. A much more serious frost occurred in January 1935 when large areas were severely damaged in the same localities as previously. This damage, while severe locally, has by no means entirely destroyed the crop, and there are also many thousand acres, untouched by frost, of excellent young sapling crops in the division which will, at maturity, give fine sound trees far finer in stocking and quality than anything that was there before.

Mr. Bhola's plan was revised in 1931 by Mr. F. W. Champion. The chief difference in Mr. Champion's prescriptions as regards

regeneration, are, that poles up to 12″ diameter, as against 8″ in Mr. Bhola's plan, are to be retained as the future crop, and cutting back is discouraged, being only permitted where the crop, if kept, would be unlikely to produce healthy trees at maturity. Also there is no limit of a minimum of one square chain in area. This is distinctly an improvement over the previous prescriptions. While the smaller crop is on the whole defective, there are many areas in which good poles up to 12,″ and even somewhat larger, can be found. Some of these may be, and probably will be defective, as they show signs of 1905 frost damage; but they have already grown up to a good size and, felled now, give no timber of any value. It has been found in Ramnagar division, that in good quality areas where trees are growing vigorously, the frost damage of 1905 did *not* cause rot to spread down the bole. Many of these have been examined in Lachampur block. So we need not be afraid to leave such poles in good localities. In bad localities, liable to severe frost damage, practically everything must be kept. This is quite evident from the areas badly damaged in 1935.

If Mr. Champion's prescriptions are carefully carried out, *i.e.*, good poles up to 12″ kept, preferably in groups, and over other areas the small defective crop is cut back, a very good crop should result in all the better frost-free areas. Mr. Champion states that "advance growth which looks weak and crooked tends to straighten up when it has been given full overhead light." This is perfectly true, but such advance growth that already has rot in it will, at maturity, only produce an unsound tree, useless for timber. The small material, which Mr. Champion states should *not* be preferred to the larger poles, is definitely mostly unsound and unfit to retain, as it cannot produce sound mature trees. This should certainly be cut back where it occurs between the groups of larger poles.

In conclusion it is suggested that at the revision of the plan we might go a step further and retain all well grown groups of poles up to 16″ diameter. A 16″ tree has roughly 2″ bark and 2″ sapwood; therefore at breast height it gives only 12″ of heartwood. Trees below 16″ produce little timber of any value. If we kept such

poles in groups and cut back most of the small misshapen useless stuff, we would produce uneven forests which, owing to liability of frost damage, are much more preferable in the Dun. The areas liable to frost damage are now well-known, and in such areas cutting back should be very sparingly done ; there are, however, extensive areas, as stated above, where even the severe frost of 1935 has done no harm whatever. If such prescriptions were made, a volume yield would be essential, as it cannot be conceived how an area yield could possibly give accurate results. This would provide some interesting work for our mathematical Pundits.

THE HOSHIARPUR SIWALIKS FROM THE AIR

By H. M. Glover, I. F. S.

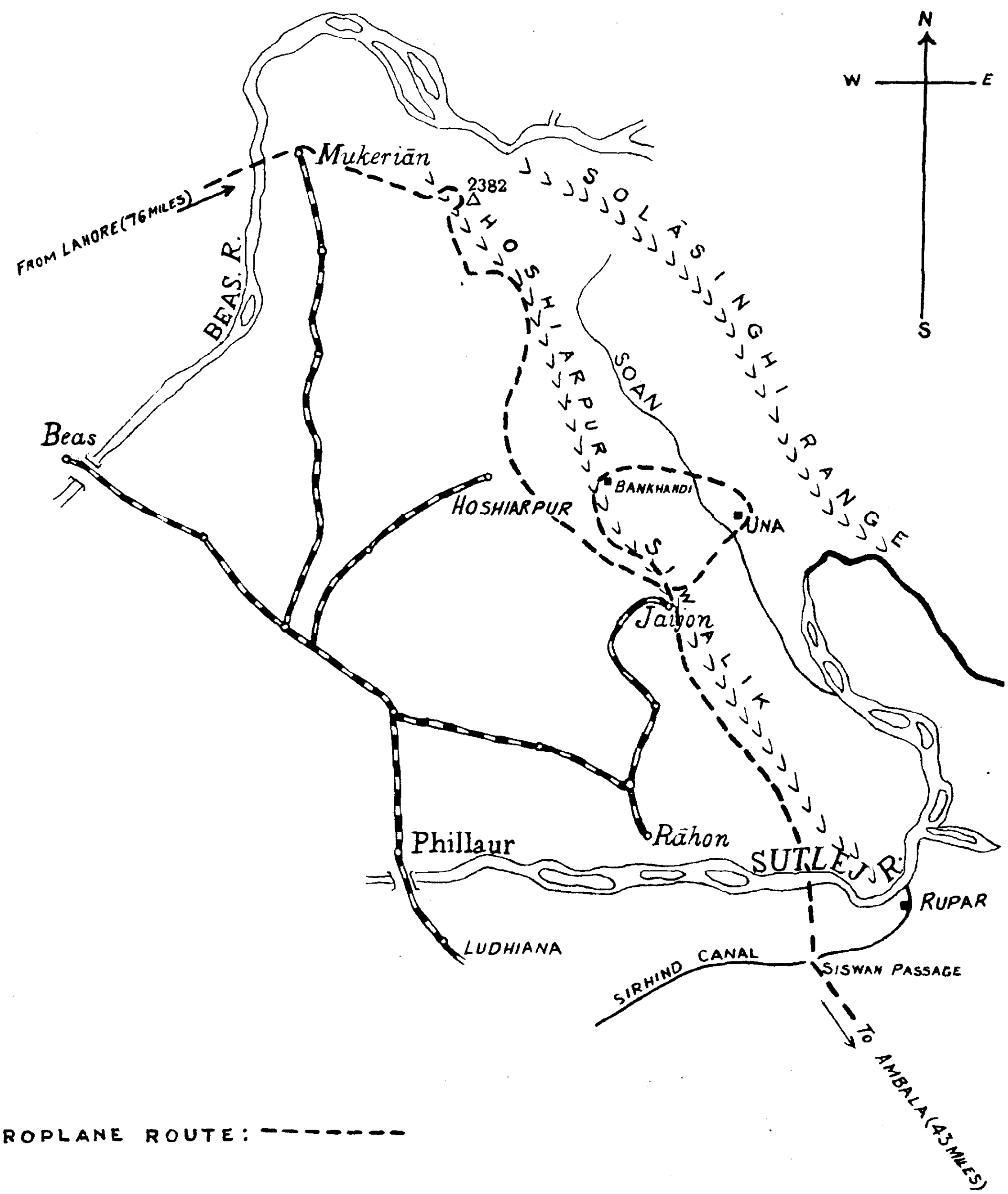
On 29th December 1935, Mr. C. W. Scott, D.F.C., Joint Timber Advisory Officer to the Railway Board and the Army, flying his Gipsy Moth aeroplane, took me over the Hoshiarpur Siwaliks, where Mr. A. P. F. Hamilton, M.C., Deputy Conservator of Forests, is on special duty with the Revenue Department in an attempt to check erosion.

The conditions in the Siwaliks are described by Hamilton in the current number of the *Indian Forester*. Scott, who is an experienced pilot, was unacquainted with the locality: a year ago I had camped along the foot of the Siwalik range with Hamilton, and on several occasions had crossed the range from Hoshiarpur. Mr. Manning of Lloyds Bank lent me a Leica camera, set to an exposure of 1/100th second and an aperture of F. 6·3 which I increased when the sun was clouded. We took two maps, a 16 miles = 1″ survey map, and a 2 miles = 1″ map of the Siwaliks. The latter I could not use on account of the pace—75 to 90 miles an hour—at which we were travelling, the absence of conspicuous landmarks, and my inexperience as an observer.

We left Lahore at 10-45 a.m., visibility being only fair, but improving later on, flying at a height of 1,500 feet and passing over Amritsar, where we could see the narrow streets and the congested

MAP SHOWING
AEROPLANE ROUTE

SCALE 1·014 INCHES TO 16 MILES

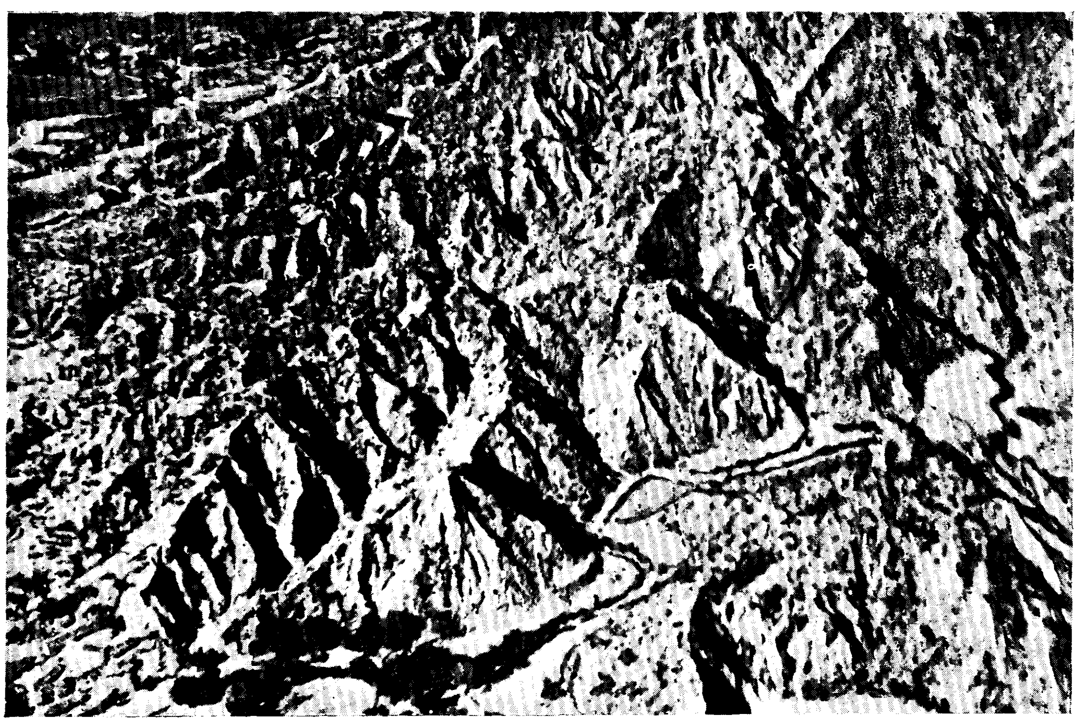


AEROPLANE ROUTE: - - - - - - -

HOSHIARPUR SIWALIKS FROM THE AIR

THE OUTER EDGE OF THE SIWALIKS, UNPROTECTED AND ERODING SERIOUSLY. DOLBAHA VILLAGE IN FOREGROUND WITH LAND RECLAIMED FROM *chos* BY USE OF *Vitex negundo* CUTTINGS BY VILLAGERS.

Photo : H. M. Glover.



THE OUTER EDGE OF THE SIWALIKS 5 MILES EAST OF HOSHIARPUR, THE LOWER LEFT UNPROTECTED, THE UPPER RIGHT INADEQUATELY PROTECTED UNDER SECTION 4 OF THE *Chos* ACT. DALIWAL VILLAGE IN LEFT FOREGROUND.

Photo : H. M. Glover.

nature of the city, the Golden Temple showing up clearly. We followed the railway line to Batala, then leaving Dhariwal and Gurdaspur on our left we crossed the Beas river above Nowshera and made for Mukerian, where we crossed the railway, and soon afterwards reached the Siwaliks with the snows of the Dhaola Dhar range showing on our left front.

Here we circled over the Government bamboo forest of Bindraban and shortly afterwards flew over the eroded areas described by Hamilton, Scott shutting off the engine in order to check vibration each time I took a photograph. We flew along the edge of the Siwaliks to Dholbaha, which I recognised from a school playground and where the hedges built to constrict the *chos* showed up clearly, left Hoshiarpur on our right and reached Jaijon, turned north-east and crossed the Siwaliks towards Una, passing over the valley of the Sohan, where erosion is proceeding unchecked and the lands are in the last stages of degradation. Above Una we turned and crossed the Siwaliks at an altitude of about 3,000 feet, leaving Hoshiarpur on our right, and again skirted the edge of the Siwaliks past Jaijon. By this time most of the photographs had been taken, and fortunately I had not tampered with Manning's setting of the camera, as I did later on with disastrous results. Scott then flew in a south-east direction parallel to the Siwaliks, crossing the Sutlej river below Rupar, where the irrigation dam was visible to our left, crossed the Sirhind canal above the Siswan syphon and then made straight for the North-Western Railway, which he followed to Ambala, where he made a perfect landing. The journey had lasted for 3 hours and 40 minutes, and to one such as myself, who had had no previous experience of cross-country flying, was full of interest.

From the air the eroded slopes show up clearly; so do sandy *chos* and one is inclined to be depressed at the extent of the erosion. Fortunately the steps taken to check erosion by means of the exclusion of goats are having their effect. The damage done by the *chos* reached its peak in the last decade of the nineteenth century, and owing to improvement in vegetation consequent on

the closures and ejectment of the goats in 1902, the *chos* now do much less damage than formerly, and lands which had been ruined by sand are now slowly being reclaimed.

Thanks to Hamilton's tact and patience and to the examples furnished in catchment areas where closure has been enforced, villagers are applying to have further areas closed to goats and to indiscriminate cutting of trees and bushes. Cattle are also being excluded voluntarily, as the damage done by them to the friable soils of the sandstone hills is very great indeed. Fodder is exceedingly scarce in the neighbourhood, and as a good crop of grass grows when cattle are excluded, numerous villages have applied to have their "shamilats" or common grazing grounds closed under the *Chos* Act. The area can never be completely restored, but erosion is already retarded and there is every prospect of training the *chos* and restricting their area.

Counter-erosion and reclamation of devastated lands is a definite part of the Punjab Rural Reconstruction programme, and the present example of what is possible with the help and consent of the people of Hoshiarpur points the way to further attempts being initiated to check denudation and erosion throughout the sub-Himalayan tract of the Punjab. The proper use and conservation of all lands on sloping ground, both cultivated and waste, is a practical problem which must be faced, as there is nowhere else for an expanding population to emigrate to. Plates Nos. 25-26 show the serious nature of local erosion.

There is also no doubt that the destruction of the forests of the Outer Himalayas, which has been accelerated by the increase in human and grazing animal population owing to the peace and safety brought by the British occupation, allows rain water to run over the surface of the ground and be wasted during the monsoon instead of being stored. Irrigation Engineers are most concerned with the decrease in the winter water supplies in the canals on which the Punjab depends for its prosperity, and they have themselves drawn the attention of the Punjab Government to the danger of allowing disforestation in the sub-Himalayan tract.

HOSHIARPUR SIWALIKS FROM THE AIR

HEAD OF JAIJON *cho* SHOWING RECLAIMED FIELDS ALONG TOP BY USE OF *watt bandi*. THESE HAVE TAKEN 3 GENERATIONS TO MAKE AND HAVE USED UP MOST OF THE RAJPUT SOLDIERS' SAVINGS BUT ARE STILL BEING CUT AWAY BY CONTINUED EROSION.

Photo : H. M. Glover.

EASTERN BRANCH OF MAHNGARWAL *cho* SHOWING ATTEMPTED RECLAMATION IN RIGHT BOTTOM CORNER.

Photo : H. M. Glover.

It is difficult for senior officers of Government, or M. L. Cs., to visit the sub-Himalayan zone and to see with their own eyes the devastation which is universal throughout the region immediately above the cultivated plains. In an aeroplane they could see in a few hours miles of eroded country.

NOTES ON GONDA DIVISION

BY R. O. DRUMMOND, I. F. S.

1. *General description*.—Gonda district lies in the north-east of the U. P., bordering on Nepal in the north. Gonda town lies some 100 miles north-east of Lucknow to which it is connected by the B. & N. W. metre gauge railway, and by road *via* Ajodhia and Fyzabad.

2. *Name and situation*.—The Gonda Forest Division is made up of two separate tracts, called the Northern forests and Southern forests, respectively.

The Southern forests are situated in the Gonda district 10 miles to the north of the Gogra river, the western portion in the Tarabganj tahsil and the eastern portion in Utraula tahsil.

The Northern forests stretch along the foot-hills and are bounded on the north, east and west by the Nepal frontier. The portion west of the Gandhela *nala* is in the Bahraich district, while the portion east of the Gandhela *nala* is in the Gonda district.

The Southern forest comprises a single block of irregular outline with an area of 13,633 acres, and in addition a separate small area of 59 acres, forming the Hanumannagar grant, bringing the total area of the Southern forest to 13,692 acres.

The Northern forest forms a compact strip of forest about 52 miles long and with an average breadth of about 4 miles forms a total area of 121,759 acres.

3. *Configuration of the ground*.—The Southern forests are situated on practically flat ground with a very gradual slope to the south and south-east. There are two large water-courses—the Manwari *nala* on the east and the Chamnai *nala* on the west, with a

few shallow depressions, covered with grass, which drain into these big *nalas* in the rains, but are dry at all other times.

4. The Northern forests are traversed from north to south at frequent intervals by water-courses with broad stony or sandy beds, for the most part dry during the hot weather. Between these water-courses, along the greater part of the southern boundary, level or gently undulating stretches of well-drained land are found, generally free from denudation, and hence of a character more or less favourable to a good growth of forest. Here and there these fertile tracts are found extending as far as the foot of the hills, but, as a rule, the ground to the north is higher, very much broken, and intersected by innumerable dry torrent beds. The high ground in some places is level, but it is always dry, unfertile, and sparsely covered with stunted trees of no commercial value. Such ground in places extends southwards beyond the limit of the forests. The general slope is to the south with a gentle gradient, but the descents to many of the water-courses are extremely steep and often absolutely perpendicular.

The uneven and variable character of the ground is entirely due to the action of water, which, during the monsoon, is extremely violent, since the tract lies at the foot of a range of steep and bare hills.

5. *Geology.*—In the extreme east and west of the Northern forests perennial streams occur, though sparsely, in the central portions. In the west, there is a permanent lake called Rajia Tal; it is possibly of artificial origin. The lower lying areas of moist fertile soil are capable of bearing valuable forests, probably of *sal*, though at present they bear only miscellaneous species, except in the extreme east and west.

6. *Climate.*—The winter months are cool and dry, the nights being generally very cold and clear and characterized by heavy falls of dew. In summer the extremes of heat often experienced in non-forest districts are never reached, and the nights remain cool practically throughout the hot weather.

Frost is negligible and no sign of frost damage is to be found,

The direction of the prevailing winds is east, but hot west winds blow in April and May.

The monsoon rains commence in June and continue until September. Occasional showers occur in October, and in January and February.

The climate in the central portion of the Northern forests is healthy, but in the east and west and in the Southern forest it is very malarious in the rains and up till the end of November.

7. *Legal position.*—The Southern forest consists of land resumed from speculators who had been given the land on condition that they introduced cultivation. When they failed, Government resumed the area, but not before all the forest had been clear-felled. The major part of the tract was created reserve forest by 1890. An area of about 200 acres has been added in the last decade.

8. The Northern forests are composed of two tracts reserved in different ways. The tract situated in Bahraich district was originally waste land, but was declared State forest in 1861. It was then declared reserved forest in Local Government Notification No. 196, dated the 28th February 1879. After final demarcation and survey in 1904, the reserve was constituted in Local Government Notification No. 151/XIV-42-1904, dated 23rd March 1904.

The tract situated in Gonda district originally belonged to the Raja of Tulsipur. When he rebelled during the mutiny, his lands were confiscated, the village lands being given to the Maharaja of Balrampur, and the waste and forest land being retained by Government were worked under the rules issued by Government for the better management of waste and forest land in 1866.

In 1879, the forests were finally declared reserve forests, free of all rights, and orders were issued limiting the use of concessions under Government notifications.

There are no rights in reserved forest, but there are numerous concessions of grazing, small timber and thatching grass.

9. *The Forest.*—The Southern forest is composed of very poor quality *sal* forest of coppice origin which provides poles and small

timber, both of which are greatly in demand to supply Gonda and the surrounding thickly populated country.

10. There are also belts of good *jamun* along the banks of the two sluggish rivers that form the eastern and western boundaries. Thatching grass is cut and grazing allowed in the several low-lying grassy swamps that occur scattered throughout.

11. The Northern forest comprises miscellaneous forest of *Adina cordifolia*, *Terminalia tomentosa*, *Holoptelea integrifolia*, *Lagerstroemia parviflora* and *Anogeissus latifolia*, and many other miscellaneous species. In the extreme east and west there are the good *sal* forests of Sohelwa and Bhamber. In the river-beds *shisham* and *khair* are common. In the ravine and barren country close to Nepal, the crop is very open and consists of stunted *Anogeissus latifolia*, *khair*, *bel* (*Aegle marmelos*) and *tendu* (*Diospyros tomentosa*).

12. *Silvicultural System.*—Most of the *sal* in the Northern forests has fairly good natural regeneration and here selection with improvement fellings is carried out.

13. In parts, however, regeneration has failed; also, in the Southern forests, the stools of most of the *sal* are exhausted and it is desirable to introduce a new stocking. In the miscellaneous forests too, the more valuable species are being replaced by less valuable species, such as *Holoptelea integrifolia*, *Mallotus* (*rohni*) and *Croton*.

14. In all these forests, therefore, we have to face artificial regeneration, and so the *taungya* system has been, and is being introduced on a large scale, wherever the soil is sufficiently level. Elsewhere the best we can do is selection and improvement, helping the most valuable species as much as we can. In ravine land, only protection, with no fellings of any kind, is the rule.

15. In *taungya*, *sal* is sown in all areas where *sal* is felled, and also in miscellaneous forests where the soil seems suitable to the species.

16. Elsewhere in miscellaneous areas *teak*, *sissoo*, *khair*, *asna* and *jamun* are sown. Teak was the most popular species as it showed

wonderful results for the first few years, but since then the appearance of teak aged 5 to 10 years is very disappointing and it is now considered to be unsuitable, except in a few places, and more of the other species mentioned, particularly *sissoo,* will be sown in future. *Sissoo* cannot be sown pure as it is then liable to devastation by fungal attack.

17. *Taungya Problems.*—The worst problems to be faced in *taungya* here are—

1. A poor type of cultivator and insufficient numbers of them. They are mostly low caste people—Chamars, Pasis and such usually absconding from their villages, because they owe money or are bad characters under police surveillance.
2. Severe damage by browsing of deer and rooting of pigs. In one plantation, sambhar have killed out all the teak by browsing and rubbing. Why sambhar should browse teak of all things is a mystery.
3. Cutting of tap-roots, and barking, by rats and porcupines. We have found porcupine barking *khair* of less than 2″ diameter to a height of 5′, and rats have killed out line upon line of *khair* and *sal* upto two years old.
4. *Water-shortage.*—Our difficulties in sinking all kinds of wells include *kankar* pans, and lower down, shingle and boulders.

18. In spite of these difficulties, however, *taungya* is being carried on at eight different centres in the Northern forests and one in Southern forests, and is fairly well established except in three of these in the north, where prospects are doubtful though work is still going on, but rather half-heartedly.

19. *Communications.*—There are good motor roads throughout the division, and one can get to within six miles of any part of the forest by car.

20. *General.*—The division is a well-known tiger forest and all blocks are booked for shooting every month except the Southern forests, which contain only a few chital, peacock and innumerable wild cattle and jackals.

21. In the Northern forests, tiger, panther, bear, wild dog, chital, sambhar and barking deer are common. Black buck occur in the western end.

22. There are sufficient jungle fowl, peacock, partridges and quail to make scatter-gun shooting quite interesting, and near Gonda itself are several *jhils* that provide good duck and snipe shooting in season.

23. One of the unusual attractions of this plains division is that in clear weather one can see the snows throughout the touring season, though this is somewhat tantalizing in the hot weather.

24. On the whole, a very pleasant division, with a sufficiency of both work and play to prevent Jack becoming a dull boy.

GRADATIONS IN THINNING INTENSITY

By M. A. Kakazai, Silvicultural Branch, F. R. I., Dehra Dun.

(Note on Dr. Gorrie's Paper)

The Classification of Thinnings (Indian Forest Record, Volume XV, Part I) accepted by the 1929 Silvicultural Conference, has been applied very widely and successfully both on large areas of forests and on small plots. In *sal* forests particularly, no difficulty has been felt in using the classification, except in the case of young crops in which the differentiation into canopy classes has not proceeded far enough. Resolution 14 (6) of the Proceedings of the 4th Silvicultural Conference, 1934, p. 225, runs as follows—" A standard classification of thinnings in young plantation crops is required on the lines of the classification of thinnings in more mature crops which have developed more definite crown classes." Suggestions are invited from all the forest officers on this problem.

Individual officers may continue to call their favourite operation a " C " grade thinning, irrespective of the above mentioned classification, but, for others who follow the Classification of Thinnings, it is well nigh impossible to prove a wrong thinning correct with the help of the diagrams in the text, unless the difference between the

actual operation and the thinnings as it should be done according to the classification is unimportant and negligible.

Dr. Gorrie's remark that the width of crowns in the Forest Pocket-book diagrams is out of all proportions to the height of the trees, and thus they depict a seriously denuded canopy with the removal of only a few suppressed and dominated stems, is worth consideration. It is interesting in this respect to see the diagrams in "The Practice of Silviculture" by R. C. Hawley, First edition, 1921, Second edition, 1929, in the Classification of Thinnings, *Forest Bulletin* No. 52 of 1922; in Mr. Howard's Pocket-book (1927), in the Classification of Thinnings, *Indian Forest Records*, Volume XV, Part I, 1930, and in Dr. Gorrie's paper together.

In making an ideal diagram, one has to consider three things: (*a*) Spacing between trees, (*b*) $\frac{\text{Length of crown}}{\text{Total height}}$ ratio, and (*c*) $\frac{\text{Width of crown}}{\text{Total height}}$ ratio.

From considerations of spacing it is clear that the diagrams proposed by Dr. Gorrie are similar to the diagrams printed in Mr. Howard's Pocket-book (1927), which are nearer the ideal than the diagrams printed in the Classification of Thinnings. The latter need improvement in this respect.

In his proposed diagrams, Dr. Gorrie has accepted the same lengths and widths of crowns as given in Mr. Howard's Pocket-book (1927), but has decreased the ratio by systematically increasing the heights of the trees.

An analysis of the ratios of crown length/total height and crown width/total height from all the available data of *Cedrus deodara*, shows that there is very little to choose between Mr. Howard's and Dr. Gorrie's diagrams, and as such, no useful purpose would be served by making any alterations in Howard's *U. P. Forest Pocket-book* diagrams.

It would be necessary to collect spacing and crown measurement data from even-aged crops for all the canopy classes in order to make diagrams to scale, and even then the resulting diagrams would apply

to one particular species; so it is obvious that this work is unimportant from the point of view of a general Thinning Classification.

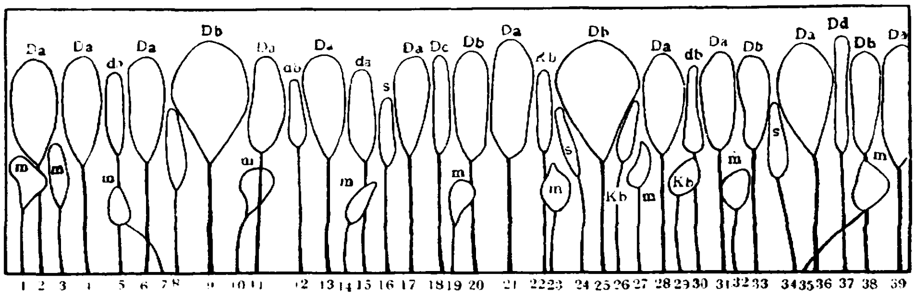
It may, however, be remarked here that the diagrams printed in the latest Classification of Thinnings, *Indian Forest Record*, Volume XV, Part I, 1930, are very much out of proportion, due to the fact that although their heights and crown measurements were reduced from older 1922 edition diagrams, their spacements were not altered. In these diagrams the lengths of crowns seem fairly correctly made as compared to the total height of the trees. The widths of the crowns of the three smallest height classes have, however, been made unacceptably large in the sketch. This is also supported by the fact that suppressed and moribund trees have usually very small and poor crowns. For the middle-height classes the widths are fairly correctly sketched, but in the uppermost-height class again they seem to have been made a little broader due probably to the intention of the authors to show wolf trees.

In the Forest Pocket-book and Dr. Gorrie's sketches, the lengths of crowns corresponding to height classes are systematically smaller when compared with the available data of *Cedrus deodara*. A set of thinning diagrams representing deodar in particular have been obtained by drawing, as closely as possible, the *Indian Forest Record*, Volume XV, Part I, trees, after reducing the crowns of the moribund trees, *vide* plate 27.

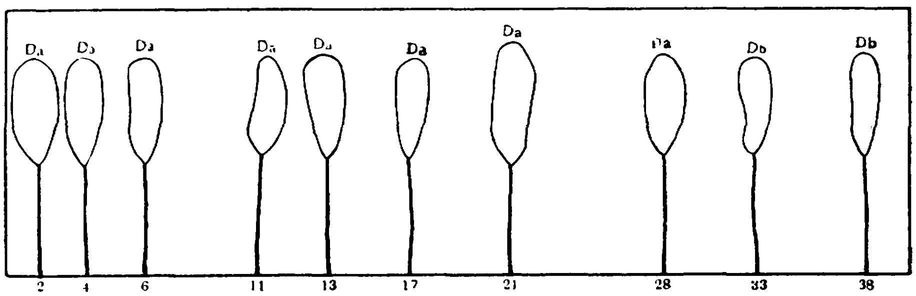
In the diagram representing Heavy Crown Thinning on plate 27, tree No. 33 with crown drawn in broken line has been retained, although it is shown as removed in the Thinning Classification referred to above, in order to avoid a gap in the canopy.

The difficulty of depicting three-dimensional forest canopy by such sketches as the illustrations under discussion, which are only two-dimensional, is insurmountable in a book, and for this reason these sketches must be studied and explained with reference to a forest crop at site. Diagrams of the projections of crowns on the ground would be very useful to show the canopy resulting from each kind and grade of thinnings.

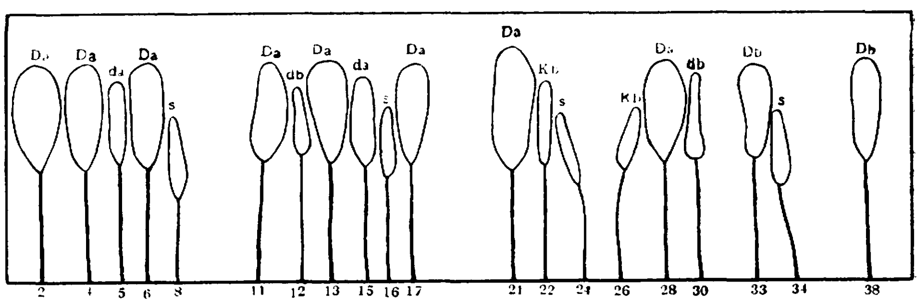
UNTHINNED FOREST.



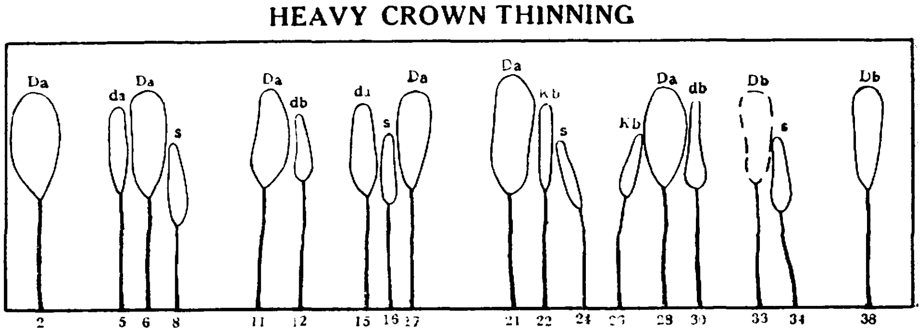
D. GRADE THINNING.



LIGHT CROWN THINNING



HEAVY CROWN THINNING



The widths of the crowns in the Forest Pocket-book diagrams are not claimed to be made to scale and may be out of proportion, but they serve the purpose of showing in a sketch the type of dominating trees which should be removed, *viz.*, the trees with very large crowns which behave like wolf trees. No confusion is caused by widths of "m" class trees. The sketches are meant to be used for explaining the grades in the forests where they apply satisfactorily.

The removal of the so-called lesser and shorter stems in case of the crown thinnings is qualified by the clause on p. 6 of the Classification of Thinnings, which runs as follows: "The removal of dead, dying and diseased trees with *such of the defective and, after them, the better dominants as are necessary to leave room for the further development of the best available trees* evenly distributed over the area." This does not differ from Dr. Gorrie's description, *viz.*, the tenets of crown thinnings, one of whose objects is to preserve these lesser stems unless they are actually interfering with one of the elite stems of the chosen future crop except for making out a case for the retention of dead, dying and diseased trees which are useless for the protection of the soil, *vide* definition on p. 5 of the Classification of Thinnings.

The alteration in light crown and heavy crown thinnings suggested by Dr. Gorrie aims at reserving all the "m," *viz.*, dead and moribund class of trees and also the wolf trees, *viz.*, Nos. 9 and 25 which have been recommended for removal in the specification passed by the 1929 Silvicultural Conference.

Further, Dr. Gorrie's light crown thinnings cannot be converted into heavy crown thinnings by removal of a few more trees as done in the standard operation. He has removed tree No. 5 in the light crown thinnings and wishes to retain it under heavy crown thinnings, and remove Nos. 4 and 6 instead, which is a defect.

Lastly, out of a total of 18 dominant trees, Dr. Gorrie has kept 10 dominant trees in the heavy and 13 dominant trees in the light crown thinning diagrams, as opposed to 7 and 10 dominant trees respectively in the diagrams given in the Classification of Thinnings, which naturally makes his diagrams look comparatively less denuded.

The trees removed in the text-book and recommended for removal by Dr. Gorrie are shown in a tabular form below :—

	D_a	d_a	D_a	D_b	D_a	d_b	D_a	d_a	D_c	D_b	K_b	D_b	K_b	d_b	D_a	D_b	D_a	D_d	D_a
Text-book light crown thinning ..	..	..	..	9	..	..	..	..	18	20	..	25	29	..	31	..	36	37	39
Dr. Gorrie's light crown thinning ..	..	5	..	..	11	..	..	15	18	..	22	..	..	30	..	33	..	37	39
Text-book heavy crown thinning ..	**4**	..	..	9	..	..	**13**	..	18	20	..	25	29	..	31	**33**	36	37	39
Dr. Gorrie's heavy crown thinning..	4	..	6	..	11	**12**	..	15	18	**20**	22	..	..	30	..	33	..	37	..

Leaving out the moribund trees.

Light crown thinnings book classification removes Nos. 9, 18, 20, 25, 29, 31, 36, 37 and 39.

Dr. Gorrie removes Nos. 5, 11, 15, 18, 22, 30, 33, 37 and 39.

While in heavy crown thinnings, book classification removes Nos. 4, 9, 13, 18, 20, 25, 29, 31, 33, 36, 37 and 39.

Dr. Gorrie removes Nos. 4, 6, 11, 12, 15, 18, 20, 22, 30, 33 and 37.

Great flexibility permitting the favouring and developing of fine individual trees is a characteristic of crown thinning method. It is therefore not surprising to see that Dr. Gorrie suggests removal of a different lot of *trees that matter*, for the " m " class trees are those which would not live until the next thinning.

It is thus evident that Dr. Gorrie is doing practically the same operation with the disadvantages of reserving the big branchy wolf trees with very spreading crowns as his *elite* stems, and allowing the " m " class trees to rot away which does not appear to be much of an improvement.

Leaving out the moribund trees the crown thinnings proposed by Dr. Gorrie would look like diagrams added to plates 6 and 7 in his paper.

The text-book operation is preferable for reason of removing the two D_b or wolf trees, *viz.*, Nos. 9 and 25, and leaving D_a tree No. 11. The other trees would automatically adjust themselves like the text-book operation.

Further, Dr. Gorrie's operation does not seem to have given any room to the " elites " to put on enhanced increment.

When the Classification of Thinnings was compiled, it was considered that probably " E " grade thinning would be undesirably heavy in practice and the same opinion still holds good. Mention of this grade of thinnings has been made on p. 226 of the *Silviculture Research Manual,* Volume II—the Statistical Code.

The tables in the Multiple Yield Tables of Deodar corresponding to this intensity of thinnings were derived from 21 measurements of special research thinning plots done during the period 1928 to 1931, and from 25 measurements of sample plots which were reduced to this intensity through accidents, *e. g.*, overdoing prescribed thinnings, and snow damage.

Similarly, in case of *Pinus longifolia,* we have only eight measurements of sample plots reaching this intensity of thinnings—seven through accidents and one thinned for research.

The spacement table published in Deodar Multiple Yield Tables was prepared for all qualities together, as the N/D curves could not be drawn for qualities separately. It has, however, been tested and found satisfactory as explained below.

The spacement table given by Dr. Gorrie for 2nd quality deodar forest on a triangular layout worked by the formulæ

$N=\frac{43560\times 1\cdot 155}{(\text{Side of triangle in feet})^2}$ have been compared with figures interpolated from Table 32.

The interpolated figures closely agree with the calculated figures, and show that there is no need for separate spacement tables for all the qualities.

As systematic error was found in Dr. Gorrie's figures for spacement, which have since been revised, his sketch comparison of "C and E" grades is out of scale.

TIMBER DEVELOPMENT OFFICER AND HIS WORK

BY H. TROTTER,

Forest Economist, F. R. I., Dehra Dun.

The amount of time and money spent by timber dealers and timber manufacturers in this country on publicity, advertising and technical service for wood, is a mere fraction of that spent by other large corporations and associations on steel and concrete, with the result that the latter have made tremendous advances in recent years and have forged ahead to the detriment of wood.

This lack of publicity regarding the excellent qualities that timber possesses has recently tended to place the timber owners of this country—the largest being the State—constantly on the defensive against substitutes which have steadily and in increasing measure encroached on the domain of wood. It is, therefore, high time that timber should do something to keep itself in its once prominent position in the public eye, and that it should once more take its proper place amongst structural materials. Some timber owners and timber dealers know the good points and merits of timber, but a great many do not, and the public certainly does not.

The public is treated to a continuous blast of advertising of steel, concrete and other substitute materials, and the Government of India have come to the conclusion that it is time that one of the greatest assets of the country, namely, wood, should be brought before the public eye in better perspective than it has been in the past. Very few materials can effectively sell themselves. They want advertising, and their good points require explaining in non-technical language. Wood is no exception to this rule. Its good points must be fully brought to the attention of engineers, architects and the public by systematic propaganda and technical service. Its great adaptability and great economy in, for example, bridge, electrical, building and marine construction, must be placed before the engineers of India. Half-truths and vague generalisations against timber should be promptly nailed to the counter, while information on cheap but efficient methods of preserving, seasoning and using timber should be broadly disseminated. Designs of modern engineering structures should be worked out and supplied to those who are not adept in such work. Government departments, in charge of important public works, should be approached and helped as regards the ever present problem of finding the most economical type of construction for various conditions of service. How many people know, for example, that weight for weight wood is as strong as steel in tension or that it is seven times as strong as concrete in compression? And again, very few engineers in India know that wood can now be made durable and fire-proof at very little extra cost, and that such wood will last for a surprisingly long time under the most adverse conditions. In short, the case of one of the tax-payer's most important possessions should not go by default.

To achieve the desired publicity, the Government of India have recently created a new Timber Development Section at the Forest Research Institute at Dehra Dun. The Officer in Charge has expert knowledge of modern engineering practices, timber mechanics and wood preservation. He has also at his disposal the resources and expert knowledge of other officers at the Forest Research Institute. He will prepare and disseminate short but instructive pamphlets

on timber problems to forest officers, engineers, engineering institutions, Government departments and the public, and he will tour India continually in an effort to bring to the notice of those concerned the economy and efficiency of properly designed and properly constructed treated wood structures. It is hoped that those interested will take advantage of this new development, and will correspond freely with the Timber Development Officer. All such correspondence should be addressed to the President, Forest Research Institute, New Forest, Dehra Dun.

SHADE-DEMANDER *VERSUS* SHADE-BEARER

BY J. N. SEN GUPTA, SILVICULTURAL BRANCH, F. R. I.

The fourth Silvicultural Conference at Dehra Dun (1934) has introduced a new technical term, *viz.*, "Shade-demander," in the *Glossary* under revision. The term has been defined as "a species requiring, at least in its early stages, some degree of shade for its normal development." This definition of a new term in Forestry seems delightfully vague, and the connotation is relative with the possibility of admitting of several provisos, and consequently, some amount of loose implication.

The shade-requirement of a species—its degree and intensity—is intimately connected with moisture in the soil available to the growing root system. It will not only be risky, but defeat its very object also, to try and prepare a list of important or semi-important forest species that might be classed as "shade-demanders" within the terms under reference. What in a temperate climate is a distinct light-demander may, in a tropical climate be a shade-bearer—if not a shade-demander. Oecological (local) and other factors may also contribute to the shade-requirement of a species.

The main point is that the requirement of a species in its *seedling stage* is no indication of its normal characteristic, as it varies from place to place and depends on several conditions. The behaviour during what may be called "*the post-seedling stage*" of a plant is the real determining factor for normal development. As such, it may be

be open to question how many species of forest plants do require shade for their normal development.

Besides, in practice, it would be extremely difficult to draw the line of demarcation between species that might be classed as "shade-demanders" and those as "shade-bearers," as these two terms are not mutually exclusive. The following illustration will make this point more clear.

The *Dipterocarps* (including *Hopeas*), in their natural habitat of "mixed evergreen forests," have not infrequently been met with coming up naturally (regeneration) below and around seed-bearers, although a dense middle story of heterogeneous evergreen species intervenes. Seedlings do appear normally following a good seed crop, and a good many of those that have a firm hold on the ground *persist* for several years under the heavy multi-storeyed shade; and, if there is a break in the canopy either by accident or by authorised selection fellings, they would naturally respond and push their heads up to the sapling and pole stage.

The mere fact that these seedlings *persist* (without thriving) in an apparently suppressed condition under heavy shade for long periods, and that some experimental *drastic* opening up of all overwood by a single operation of clear-felling resulted (in some cases) in heavy casualties, made very many forest officers naturally conclude that the *Dipterocarps* and *Hopeas* are shade-bearers, almost to the extent of being shade-demanders in their early stage.

The result is that the progress in natural regeneration has been very slow and tending operations very halting in some Provinces—the average height growth of *Hopea* or *Dipterocarp* there is hardly 10 ft. in 10 to 15 years.

Some amount of diffused or side shade is certainly beneficial—it is absolutely necessary where there is a prolonged period of drought rendering the soil almost what may be called "bone-dry"—during the first two or three years of establishment, for which even in artificial regeneration of *sal* (pre-eminently a light-demander) one would suggest a nurse crop like the *Tephrosia*, but that does not indicate that the *Dipterocarps*, or the *Hopeas*, or the *Shoreas*, are anything but light-demanders. Systematic experiments have proved, at least in one Province, that they are so (*i.e.*, light-demanders).

I would, accordingly, sound a note of warning that the implication of the new term "shade-demander" might—unless clearly defined—be capable of some amount of loose thinking. As it is, about 90 per cent. of our forest species (if not more) might come under the definition.

EXPERIMENT WITH "ATLAS" TREE-KILLER

[COMPILED BY THE SILVICULTURAL BRANCH, F.R.I.]

(Progressive Report)

Locality—Asarori, Dehra Dun Forest Division; *Altitude*—2,533′; *Mean annual rainfall*—About 69″;

Type of forest—*Shorea robusta* mixed with *Terminalia*, etc., typical of the Siwalik.

Mark on tins	Dilution	Method of application of tree-killer**	Number of climbers treated, with species, if possible	Date of treatment	No. killed in months: 1	2	6	Total	Balance still alive (some with new shoots)	New shoots from the root stock of killed climbers. (Rains growth)	Remarks
Specimen solution A	2 of solution to 1 of water	(*i*) Cut and painted ..	25 Spp. *Bauhinia vahlii*, *Millettia paniculata* and *Vitis* Spp.	27th March 1935	9	11	1	21	No. 4	5	In the *control*, with cutting and frilling only (without the application of the poison), the number of casualties to date has been as follows:— With cutting only=3, all *Vitis* Spp. With frilling only=2. Total 5.
		(*ii*) Bored and filled ..	25		5	16	2	23	2	1	
		(*iii*) Frilled and painted	25		1	17	2	20	5	3	
										Total 9	
Specimen solution B		(*i*) Cut and painted ..	25		6	14	2	22	3	6	
		(*ii*) Bored and filled ..	25		1	15	6	22	3	3	
		(*iii*) Frilled and painted	25		3	17	3	23	2	1	
										Total 10	
									Grand	*total* 19	

** *Explanatory Notes.*—(*i*) *Cut and painted* :—Climbers cut out, leaving (in each case) about $1\frac{1}{4}$ ft. stump which was split into 4 to 6 pieces, and then the poison applied to the stump with a brush.

(*ii*) *Bored and filled* :—A hole 4″ to 6″ deep with $\frac{1}{2}$″ to $\frac{3}{4}$″ diameter was bored, which was filled up with the poison solution and plugged.

(*iii*) *Frilled and painted* :—The lowest $1\frac{1}{2}$ ft. of the climber, just above ground, was frilled by regular slanting axe cuts around the bole, and the poison solution splashed into the cuts with a brush.

PLANTING OF PINUS LONGIFOLIA PLANTS RAISED IN TIN TUBES

BY KHAN MUHAMMAD KHAN,

E.A.C.F., Peshawar Forest Division.

Malakand Agency forest came under the control of the Forest Department in 1932, and the Cherat Cantonment forest in the year 1933. In both these forests, which lie between 3,000—3,500 feet elevation, the Department was charged with planting of *chir* (*Pinus longifolia*) plants, purely from an æsthetic point of view. *Chir* is not indigenous to Cherat forest, the crop consisting mainly of olive; and in Malakand forest it is of the low hill type mixed with a predominant crop of *sanatha* and olive. The underlying rock is limestone in Cherat, and shales in Malakand, the soil being very shallow, particularly in Cherat. The rainfall in both places does not exceed 20 inches annually. It will be obvious from the above description that the conditions for the propagation of *chir* in both these forests are far from ideal. In 1932 and 1933, *chir* seed was sown in a large number of patches in both these forests in June. The seed germinated profusely in the monsoon rains, but by the end of October, every single seedling had died, evidently on account of drought. It was then decided to raise *chir* plants in circular tin tubes 9″ long and of 2″ diameter. The seed was sown in these tubes in July-August, and it germinated in almost every tube in about a month, and by July of the following year the seedlings were about 6″ high and were planted in pits. The plants were hand-watered at the time of planting, and again whenever a long dry spell occurred until November. The planting on these lines has been carried out now for the last three years. The results have been satisfactory and nearly 50 per cent. of these plants have survived: plants more than one year old have established themselves, and the tallest 3-year-old plant is now $2\frac{1}{2}$ feet. From the above description it would appear that this method of tube planting of *chir* can be expected to give fairly good results in poor localities, and the results with this method should certainly be better in localities which form the natural habitat of this

species. The cost of tube planting is high chiefly due to the hand-watering during spells of dry weather, but it should be possible to eliminate hand-watering in localities and in years in which the rainfall is adequate and normal.

A BRASS GAUGE FOR USE IN MAKING TEAK STUMPS

BY A. L. GRIFFITH,

Silviculturist, Madras.

1. General district plantation practice and also research in Madras in recent years have demonstrated the necessity of getting the best height growth and full stocking as early as possible in the first year of a teak plantation.

2. Following this general aim we have progressed through the stages of raising plantations by direct dibbling of seed, by transplanting of seedlings, and finally by the method of stump planting.

3. The technique of raising teak plantations has reached a very high standard, and it is a poor plantation that is not 95 per cent. stocked (or more) at the end of the first year. In fact during this last year in one district it was not possible to repeat an experiment on watching the fate of second year casualty replacements, because in no part of the area were there sufficient casualties to be replaced.

4. Recent research on stump planting has been designed to endeavour to improve methods further to try and reduce this possible 5 per cent. of failure and to get better early growth.

5. The following definite results have emerged from this research :—

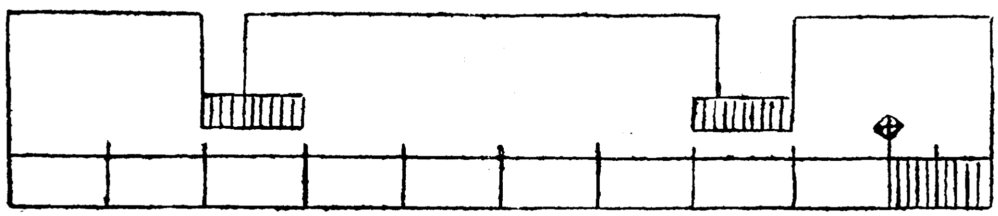
(*a*) The diameter of the stump used does matter and there is a definite range of diameter which gives the best results both in survivals and height growth. Stumps smaller than this range can be left in the nursery for another year, and stumps larger than this range are best discarded.

(*b*) The age of the stump matters very little provided the stump is within this best range of diameter.

(*c*) The length of the root of the stump within a range of 4″ and 10″ does not matter so long as the stump is not whippy at the end and likely to be bent or broken in planting.

(*d*) The best date for stump planting is six weeks to two months before the normal breaking of the south-west monsoon.

6. To apply these results in practice with the least trouble (and we have often to deal with very poorly educated subordinates) a brass gauge has been evolved as shown in the following diagram :—



Scale Half Size.

7. The two openings in the top of the gauge are the maximum and minimum diameters of the best range mentioned in para. 5 (*a*) *supra*. The diameters are taken at the fattest part of the stump. (*Note.*—When the research was started we used the diameter at the collum, but this was found too exacting for the average subordinate and was given up in favour of the "fat" diameter.)

8. The gauge is 10″ long and the bottom is marked off in inches, so that the ordinary stump with 1″ stem and 9″ root can be cut by it.

9. The method of using the gauge is as follows :—

When a nursery plant is dug up for stumping, if it is small enough to go into the small opening of the gauge it is too small for use and should be put back in the nursery for another year. If it is too big to go in the big opening, it is too big for use and should be discarded. The stump can be cut to size [*vide* para. 5 (*c*) *supra*] by the scale at the bottom of the gauge.

10. The above may sound rather technical, but it is a first attempt to give a definite standard to replace such terms as "stumps as thick as a pencil" or "stumps as thick as a man's finger," etc., which are used so frequently.

FUEL CAMP ATHLETIC ASSOCIATION

BY A. LONG, P.F.S.

It is not generally known that such an association exists, although most people in the Delta districts have knowledge of the existence of a Fuel Camp in the mangrove forests in the Moulmeingyun Township of the Myaungmya district. The camp is a very large one and unlike any other extraction camp in the Province. It is the only organized extraction agency of its magnitude in Burma and moves from place to place according to the areas declared to be open to the extraction of *kanazo* (*Heritiera minor*) by the Forest Department. Extraction moved into the Nyinaung Reserve in April 1934. The camp comprising of about 1,000 houses and about 4,000 souls, including 52 brokers, besides sub-brokers, and about 2,000 wood-cutters, is at present situated near Kyetsha village.

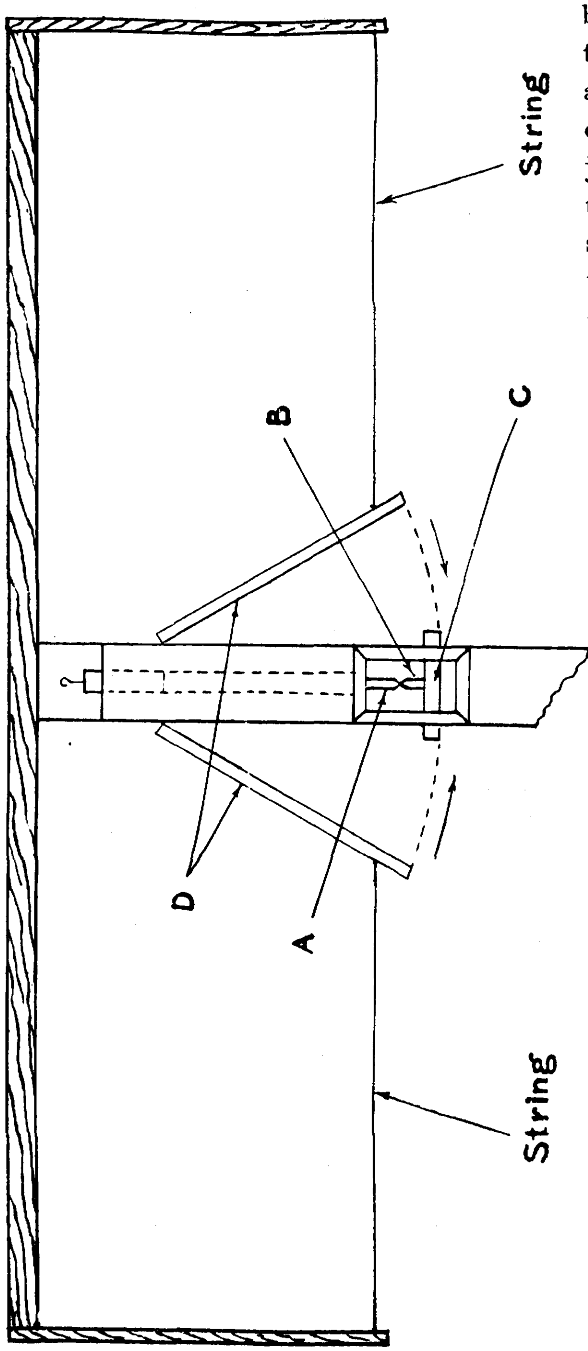
It is with the object of making some of its activities known to the general public that this short account is written. The association is of comparatively recent origin, having been started in the regime of U Pe Kin, E. A. C. Forests, who has been responsible for its inception and who is its leading spirit.

Persons who are familiar with the life of a fuel-broker, and especially that of the fuel-cutter, know what an arduous and monotonous existence it is, and it was with the object of relieving the tedium of this struggle for existence, and of enlisting the support of the people on the side of law and order, that the association was formed. It has as its objects the promotion of all sports, and endeavours to foster in the men a team spirit and a sense of *esprit de corps*. These objects are normally difficult of attainment considering the unpromising material available ; but the credit of achieving the above objects must be given to the officer who has been responsible for this innovation in the camp life of the fuel-cutter.

The activities of the Association comprise a football club, a boat club, and a reading club, and are administered by a committee formed from the fuel-brokers. The Forest Officer in charge is *ex officio* Honorary Secretary, but the other officers of the association, including the President, are elected by vote.

Each of the 52 brokers enters a team, and it will be realized from the number of teams that the only possible system that can be adopted is that of the knock-out system. Football has to be played under great difficulties, and as suitable grounds rarely exist the players are generally unrecognisable after their bath of Delta mud when they come off the field. Mr. H. V. Tollemache, the Divisional Forest Officer, fostered the new activities and gave a Football Challenge Shield to be competed for annually. This incentive to greater ardour on the part of the foot-ballers resulted in very keen competition during the knock-out tournament in which 52 teams took part. After fighting their way through the numerous matches, broker No. 5's team was declared the winner. The shield and medals were presented by Mr. Tollemache before he proceeded on leave. The F. C. A. A. football team also played matches with other villages, both on their ground and elsewhere. Considering that the game has been taken up comparatively recently, the standard of play may be said to be good and clean.

Fortnightly competitions in boating are held during the season and consist in a series of three races between two crews selected for the purpose. Special care is taken to ensure that the boats used are as equally matched as possible, and any inequality in this respect is further eliminated by an exchange of boats between races. A wooden automaton serves as a judge and is erected in a large *bauktu* (boat) at the winning post. It consists of a central upright chamber, rectangular in section, containing a vertical guide in which an iron-tipped knife-edged upright, " A " moves. This is balanced on the " knife-edge," " B " of the horizontal bar, " C " which is placed in the middle of its run for this purpose. The lateral displacement of this horizontal bar, which is actuated by the dropping of the hinged arms, " D " causes the knife-edged upright, " A " to drop, and its position with respect to the " knife-edge," " B " of the horizontal bar indicates the winner. (See sketch on next page.) As each boat is provided with a *dah* fixed to its prow to cut the string stretched on either side of the judge, the rowers are able to devote all their attention to attaining the maximum speed possible. The racing



boats being confined to a small width, about ten feet on either side of the judge, the cox, if the term can be used in such a case, has to use great judgment to keep his boat straight and true. Considering the turn of speed possible from these boats which have been built for strength, rather than speed, it will be realised that the lot of the persons on the judging *bauktu* is not without excitement. The racing boats not infrequently crash into the judge and it is only its stout construction that prevents the timbers from being torn apart. The introduction of the automatic judge for which U Pe Kin is responsible is accurate to a split second, and very rarely does a dead heat occur; in fact, this has not

been known to occur in actual practice, although it is possible. As the population spend the greater part of their lives on the water, it can be imagined how popular this regatta is. While it is in progress all work is suspended. Here also each broker enters a crew and the competition is held on the knock-out system. The serious business of determining the best crew is sometimes enlivened by having a women's "twelve" instead of a men's "twelve," and this race causes intense excitement and is greatly applauded.

Boxing (on European lines, *i.e.*, with gloves) has also been introduced, and the people have taken to it with inspired zeal. A rectangular court 20′×20′ with tightly strung ropes serves as a ring. Boxing matches have been arranged with the Police Station Staff at Moulmeingyun.

The reading club takes in about half a dozen magazines and Burmese papers, among which are the "Sun" and the "New Light of Burma." It is well patronised. Other activities are provided for in table tennis, Corinthian Bagatelle and Tennis—quoits. Basketball has also been suggested.

The administration of such a large community consisting of a floating population of about 4,000 souls usually presents great difficulties, especially as it attracts to itself all sorts and conditions of men, among whom are undesirables from many districts. The association, however, combining as it does physical as well as mental recreation besides helping to form character, that is, putting into practice *mens sana in corpore sano,* has done considerable good in diverting all thought and action into rightful and lawful channels. Besides giving employment to the unemployed of many districts, the camp, and especially the association, has done much to unite the brokers thus making concerted action on their part to control the fuel market, and, to a lesser degree, to reduce forest offences, possible.

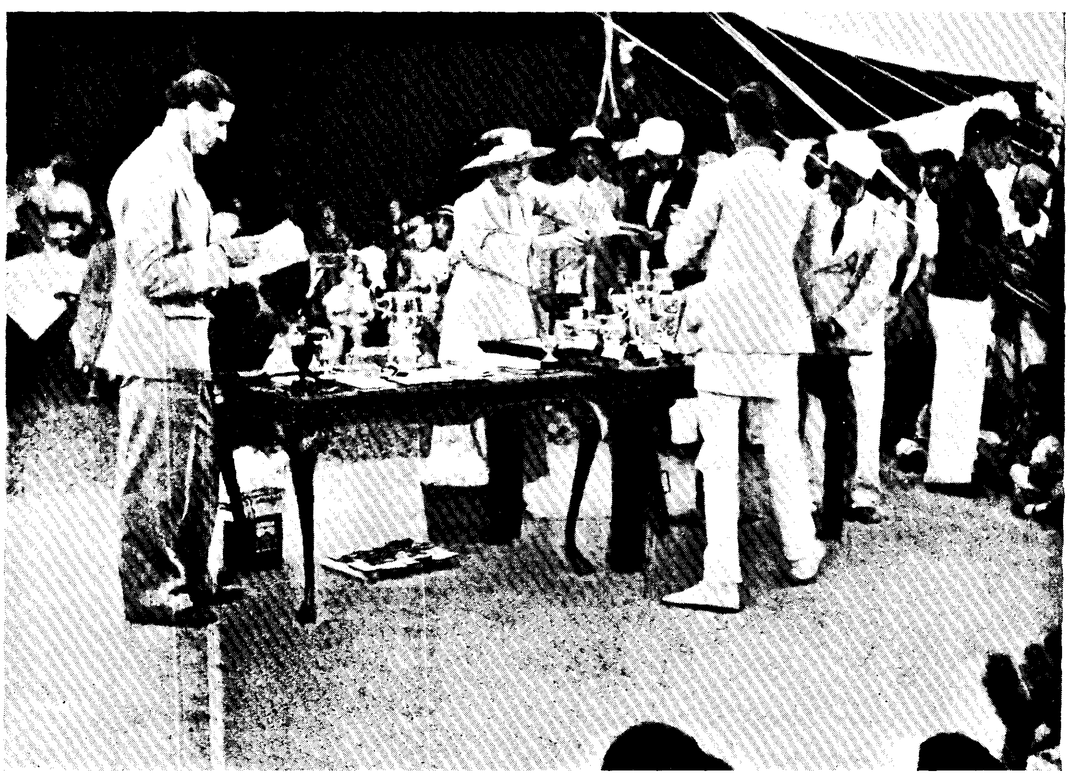
A new interest and a new factor in the rural uplift of the people has thus been introduced by the Forest Department into the village life of the Delta, which like the seeds of the mangrove species is sure to be disseminated by the tide of human activities to all parts of the Delta ; and it is not too much to hope that the movement will also be reflected in other parts of the Province.

EDITORIAL NOTES.

Sal Regeneration.—In our present issue we publish an article by Mr. W. A. Bailey on regeneration in the Dehra Dun forests. Any one reading the present plan might easily imagine that the prescriptions of the 1923 plan were very faulty and had resulted in failure. This is far from being the case, as will be seen from Mr. Bailey's article. Damage from frost has occurred in certain limited areas, and here the management prescribed in 1923 has broken down, but over thousands of acres a sapling crop has been obtained far better than anything ever produced before. The present plan discourages cutting back on the grounds that in the previous plan this was carried out to an excessive degree, but the pendulum has now swung to the opposite extreme, and if the present plan is interpreted literally the crops of the future will consist largely of unsound trees. We agree that on account of the frost factor a more unevenaged type of forest is indicated in Dehra Dun, and having now seen these forests for 15 years, we consider that the best management is to retain only what is sound and fit to retain and to cut back everything else. There appears to be a tendency in working plans to scrap what has been done before and to seek after some new thing. Because a volume yield has not given satisfactory results, instead of making it satisfactory, we turn to a calculation of the yield by area with no guarantee that this is any better. The only real way of examining a yield is to determine what percentage of the growing stock is to be removed. The figures desired by the Empire Forestry Conference include figures of the growing stock of our forests, but only too often working plans make no attempt to ascertain the real growing stock, although under the standards of scientific forestry attained by us this should be one of the most important duties of every working plans branch. A working plans officer should seek to build on what has gone before, to eliminate defects, to improve technique rather than to devise something different and new. Impatience is a bad fault in forestry, especially in the case of *sal* regeneration, and because regeneration

F. R. I. AND COLLEGE SPORTS, 1936

SACK SCRIMMAGE—ONE OF THE MANY INTERESTING EVENTS.



MRS. TREVOR DISTRIBUTING THE PRIZES.

has not been obtained over a few years, this does not mean that patience will not in due course be rewarded.

* * * * * *

The Forest Research Institute and College Sports, 1936.—The combined Forest Research Institute and College Sports were held on March 28, 1936, at the New Forest. A beautiful track was laid on the lawn on the northern side of the main building. The members of staff of the Forest Research Institute and College were "At Home" to the staff of the local educational institutions, including the Indian Military Academy, the Prince of Wales's Royal Indian Military College, the Dun Public School and to their personal friends, which included most of the officials of the station and the gentry of the town. The arrangements for the " At Home " were made by Mrs. Trevor, and Mr. W. T. Hall, Director, Forest College, assisted by a committee, was in charge of the sports.

Besides the various races, the high jump, the hurdles, the sack scrimmage, the obstacle race and the spar fighting, the performance included a menial staff race, the officers' handicap race, and two races for children. The children's races were much enjoyed by the spectators.

For the tug-of-war and the relay race, the teams from the Forest Research Institute competed against those from the Forest College. The Forest College got an easy victory in the tug-of-war, but in the relay race, the Forest Research Institute took away the trophy, for which a good deal of credit goes to Mr. G. S. Rana. Unfortunately the 1st Forest Research Institute competitor in the relay race fell down just before completing his 100 yards. However, he got up and handed over the token to the next competitor of his team, Mr. G. S. Rana, who not only made up a distance of about 10 yards, but was also well in advance of the Forest College competitor when he handed over the token to the next man of the Forest Research Institute team. The sack scrimmage and the spar fighting created a good deal of amusement.

It is interesting to note that the trophies for the various events had been divided almost half-and-half between the staff of the

Forest Research Institute and the students of the Forest College. There was a keen contest for the championship cup throughout between Mr. M. S. Rana of the Forest Research Institute and Mr. Mohd. Azim of the Forest College. It was surprising to know that both of them qualified themselves for the championship and instead of one, two championship cups had to be given.

The programme was kept to time and Mrs. Trevor gave away the prizes.

After the sports prize-giving had been finished, the prizes for the tournaments held under the auspices of the New Forest Club were given away by Mrs. Trevor. They consisted of running cups for Football, Hockey, Badminton and Tennis. The New Forest Club held tournaments for these games, which were open to the various sections and branches of the Forest Research Institute and the Forest College. Besides the outdoor games, the tournament for the indoor games, *viz.*, Chess, Carrom, Auction Bridge and Ping-Pong were also held and prizes were given to winners.

In tennis a number of interesting and contested matches were played. A good deal of interest was taken in the " mixed doubles." A Tennis championship cup was awarded to Mr. Nand Lal Dev Varman of the Forest College for having won in all the four events of the tennis tournament.

After the prize distribution the function came to a close with three cheers for Mrs. Trevor.

Our thanks are due to Major Hudson who discharged the duties of Starter most admirably.

All the functions went on without any hitch, for which credit is due to the Sports Committee.

It is hoped that these sports and the various tournaments under the auspices of the New Forest Club will be held annually.

The names of successful competitors are given below :

Long Jump—	M. S. Rana (F. R. I.)	..	1
	Md. Azim (F. C.)	..	2
Putting the Weight—	Muzaffar Ali (F. C.)	..	1
	Md. Azim (F. C.)	..	2

Throwing the Cricket Ball—	Md. Azim (F. C.)	..	1
	Ashiq Hussain (F. R. I.)	..	2
High Jump—	M. S. Rana (F. R. I.)	..	1
	Ashiq Hussain (F. R. I.)	..	2
100 *Yards Race*—	G. S. Rana (F. R. I.)	..	1
	M. S. Rana (F. R. I.)	..	2
Hurdles—	Md. Azim (F. C.)		1
	M. S. Rana (F. R. I.)	..	2
Sack Scrimmage—	Nathi Singh (F. C.)	..	1
	Ram Nath (F. C.)	..	2
220 *Yards*—	G. S. Rana (F. R. I.)	..	1
	M. S. Rana (F. R. I.)	..	2
Tug-of-War—	Forest College		
Relay Race—	Forest Research Institute		
Officers' Race—	Mr. C. G. Trevor	..	1
	Mr. W. T. Hall	..	2
Half Mile—	M. S. Rana (F. R. I.)	..	1
	Md. Azim (F. C.)	..	2
Obstacle Race—	Mazir-ud-Din (F. C.)	..	1
	Md. Azim (F. C.)	..	2
Spar Fighting—	Lalji (F. C.)	..	1
	Nur-ul-Hassan (F. R. I.)		2

1. *The Forest Football Challenge* .. *Winners*, 1936—The Borers. (Cup presented by Sir Alexander Rodger.) (Entomology team).
2. *The Mason-Jaspal Hockey Cup* .. *Winners*, 1936—Forest College.
3. *R. K. Bannerjea Memorial Cup for Badminton* .. Winners—Mr. Nand Lal.
   Mr. A. N. Bannerjea.
   Runners-up—Master Brij Nath Kapur.
   Master Jawahar Lal.

TENNIS

4.	*Open Singles.* (Cup presented by Mr. A. D. Blascheck.)	Winner—Mr. Nand Lal Runner-up—Mr. Latifullah
5.	*Mixed Doubles*	.. Winners—Miss M. Trevor Mr. Nand Lal Runners-up—Mr. and Mrs. Hall
6.	*Handicap Doubles*	.. Winners—Mr. Nand Lal Mr. U. S. Madan Runners-up—Mr. B. S. Varma Mr. S. P. Sahi
7.	*Open Doubles*	.. Winners—Mr. Nand Lal Mr. A. N. Bannerjea Runners-up—Mr. W. T. Hall Mr. U. S. Madan

INDOOR GAMES

8.	*Auction Bridge*	.. Winners—Mr. Chheda Lal Mr. H. K. Mukerjea
9.	*Ping-Pong*	.. Winner—Mr. Mahesh Prasad Runner-up—Miss Limaye
10.	*Carrom*	.. Winners—Master Brij Nath Kapur Master Gopi Nath Kapur
11.	*Chess*	.. (*i*) Winner—Mr. B. S. Varma (*ii*) One prize to Master Limaye for having played a very good game for his age

Summary of a lecture delivered by Mr. C. G. Trevor, C.I.E., I.F.S., Inspector-General of Forests, Forest Research Institute, Dehra Dun, on a " Tour in South Africa."

Mr. Trevor, who represented the Government of India at the Empire Forestry Conference held in South Africa, gave a very interesting account of his tour in that country.

He gave a brief history of the country from the date when the Cape of Good Hope route was discovered in 1647 to the present time.

South Africa, he said, was dry and resembled Central India, except for the fact of elevation. It is this matter of elevation above the sea of 5,000 ft. that makes most of South Africa habitable for Europeans. Rainfall seldom exceeds 30″ except on the east coast, where the rainfall is between 35″ to 50″ and on the escarpment of the Drakensburg in the Northern Transvaal where the rainfall reaches 80″. It is a curious fact that usually the soil is poor where the rainfall is high, as in the south-east of the Cape Province, while it is comparatively fertile in the area of low rainfall.

Coming to the agriculture of South Africa, the Inspector-General said that the Colony produces large quantities of grapes, oranges and other fruits. There are extensive vineyards near Cape Town and large quantities of high class grapes ; other fruits and wine are exported to London and Calcutta markets. Though the area was not suitable for growing wheat still it has been grown in the south under heavy protective duties.

The greater part of the Union was practically treeless, consisting of extensive undulating grass plains with scattered flat-topped mountains. The area under natural forest is very small. There is a limited area of temperate rain forest consisting of stinkwood (*Ocotea ballata*) and Podocarps, etc. The former is highly prized for furniture and decorative work like the Indian rosewood and fetches very good price. The yellow woods, and especially stinkwood, have been heavily exploited in the past. They are considered slow-growing and their propagation from a financial standpoint unprofitable. It appears that Podocarps could be grown to

maturity at a rotation of 150 years. The Indian foresters are, Mr. Trevor said, accustomed to rotations of such a length and even more, and he thought it a wrong policy to give up the propagation of such valuable species as Podocarps simply because they are not as fast-growing as the exotic pines, for which the rotations of 30 to 40 years have been considered suitable. There are extensive areas covered with thorn forest and grass of no commercial value at all. He described the peculiar vegetation of the Karroo and the many types of Mesembryanthemum found there and their peculiar methods of seed disposal. In the Cape Province with a winter rainfall a vegetation of great floral beauty—mostly ericaceous—exists, but it is of little or no economic value. An attempt is being made to propagate some of these plants in the Botanical Gardens of the Forest Research Institute.

In the indigenous forests, the work was almost entirely done by people who have settled there from the early days and made their living in this way. This class of people have now the sole right of purchasing the trees marked for felling.

Mr. Trevor mentioned that the first Chief Forest Officer who was responsible for the organization and development of the forest department in South Africa, more than any other single man, was Mr. Lister, who commenced his career as a Forest Ranger in the Punjab.

The speaker referred to the plantations of conifers established in the Union and pointed out that the work done was very creditable. The main object of these plantations is to supply pit timber for the Johannesburg gold mines. These mines require enormous quantities of timber, and until recently all of this was imported. The plantations now supply all the round props of eucalyptus and wattle, but are not yet sufficiently mature to supply coniferous timber.

Mr. Trevor gave an interesting account of the work in the Johannesburg gold mines and pointed out that but for these mines, the country would be in a bad way. It was the gold and diamond mines which produced wealth in the country and attracted so many people who have made a permanent home there. At present, the speaker said, when the price of gold was high, the people engaged

in these mines were highly prosperous, but what the condition of the owners and the labour would be when the prices go down cannot be viewed with equanimity.

Amongst the wild animals most commonly met with in the Kruger National Park, are lions, zebras, giraffes, elephants, antelopes and the hippopotami. Rhinoceros are also found in Zululand. He contrasted the Indian and the African elephant and mentioned that the latter had much bigger ears than the former. He further remarked that in cinemas when the Indian elephant was disguised as the African, they added on rubber ears. He showed an interesting collection of photographs of wild animals, most of which were taken in the Kruger National Park. He considered one of the most beneficial acts done by President Kruger was the establishment of this Park, where one could see wild animals under perfectly natural conditions. These animals are so tame that it is possible to take their photographs from a car. The speaker hoped that the Forest Department in India, and others, would endeavour to do something similar to preserve the wild animals of this country, some of which are at present in great danger of being extinguished.

* * * * * *

British Industries Fair.—In *The Times* for 29th February, 1936, is a reference to the British Industries Fair, in which it is stated that India has done especially well and has sold lamb, leopard and wild cat skins to London and the continent, and Europe. It is to be hoped that forest officers in this country will do everything they can to discourage the commercialisation of the wild animals of this country, which is generally attended with revolting cruelty, and is carried on without any regard for the law.

* * * * * *

Note on Sageraea.—Attention has been drawn by the Forest Economist to the excellent quality of the timber of *Sageraea elliptica* (chooi or bow-wood) from the Andamans as a tool-handle wood. It has been found to be as good as, if not superior to the finest hickory. The tree also occurs in Burma, and there is a very

similar tree known as *Sageraea listeri* in the Chittagong Hill Tracts which may prove to be identical with it, and is also reputed to have timber of excellent quality. The habit is tall and straight-stemmed with characteristic smooth bark, dark-brown with white patches, peeling in long thin strips. The tree grows in semi-evergreen forests and may benefit from light shade in youth. It is evident that the species is worth a thorough trial wherever plantations are in progress in the type of forests in which it is found, the supply from natural forests being so limited as to render it valueless for large commercial work. The Forest Botanist is endeavouring to arrange a supply of seed for trial and it is hoped to secure enough to distribute to those who are in a position to make a serious test with it.

* * * * * *

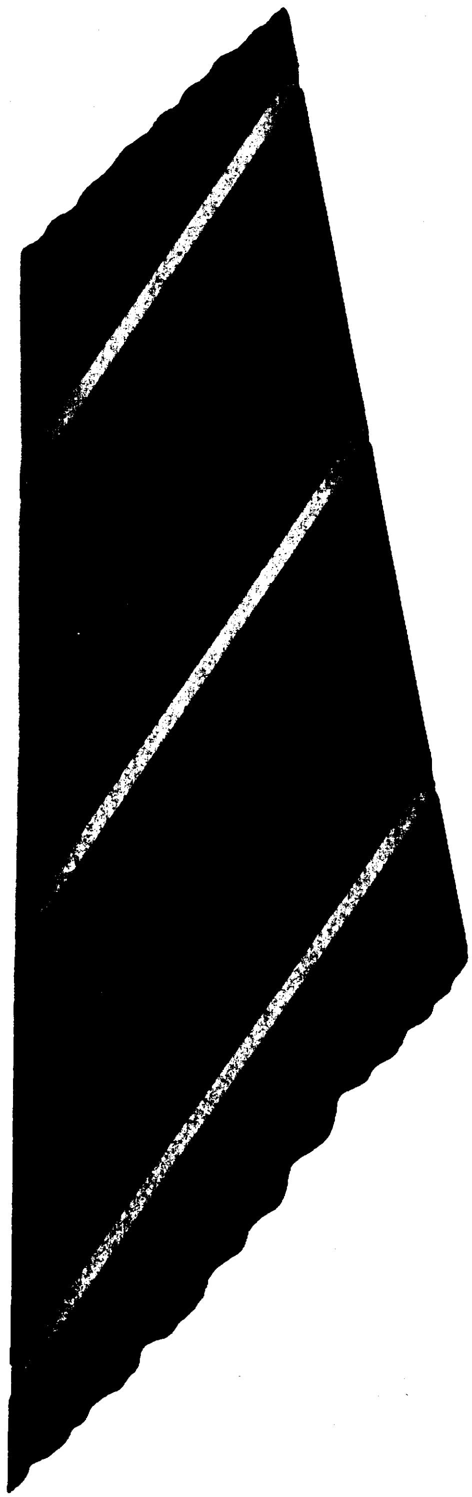
Improvements in the Horticultural Industry.—The Research Station at Sabour devises possible lines of improvements in the horticultural industry of Bihar and Orissa and the United Provinces. It covers mainly the propagation, culture, trial of varieties, fruit bearing, marketing and preparation of by-products of mangoes, *lichis* and papayas. Mangoes are propagated by inarching besides the usual method. The gootee method for *lichis*, though a little expensive, is more successful.

The Station is making observations on the effects of rainfall, temperature and other weather conditions, on the dates of commencement, full blossom, and vegetative growth of fruit-bearing trees.

Besides this, the Research Station undertakes to give training to people who desire training. Also, it sells the best kinds of plants that are supposed to be reliable.

* * * * * *

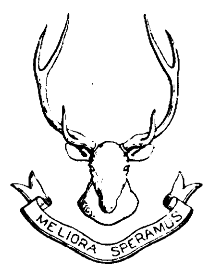
Indian Forest Service Colours and the Crest.—A note was issued in the *Indian Forester* of January 1936 on this subject, as a result of which several officers expressed their views in letters. Some of these views were summarised in the issue of March 1936. As various suggestions were made, the Inspector-General of Forests appointed a small committee consisting of Dr. C. F. C. Beeson,



Capt. H. Trotter and Messrs. W. T. Hall and L. R. Sabharwal to go into the question of Indian Forest Service Colours and the Crest, and report to him for his final decision. As a result of the deliberations of this committee, and with the approval of the I.G.F., the following crest and colours have been adopted :—

Colours.—Black, with narrow bands of green, as shown in the diagram.

Crest.—As illustrated below :—



Majority of the officers who have expressed their views agree that this crest would be most suitable, and it is hoped that the service, as a whole, will approve of the above decision. It is proposed to ask some cloth mill to manufacture and submit a sample of cloth showing these colours for approval. When this is done, then the Army and Navy Stores, Bombay, and a firm in Ludhiana, will be requested to stock these colours as well as the crest.

All other colours and crests of whatever design and description they may be will henceforth be considered unauthorised.

REVIEWS

RESEARCH ON LAC

LAC AND THE INDIAN LAC RESEARCH INSTITUTE, BY DOROTHY NORRIS, M. SC., F.I.C., P. M. GLOVER, B. SC., AND R. W. ALDSI, PH. D., D.I.C., 2ND EDITION, JULY 1935, CALCUTTA, PRICE RS. 2-8-0.

One of the most difficult duties of a Research Institute is to put up before its interested public an account of the practical results it has achieved. The task is really two-fold, for the most conscientiously written account is useless if it is not effectively put across to the public who should read it.

When the scientific staff of the Indian Lac Research Institute at Namkum, near Ranchi, published a record of their work in 1934, they produced a most attractive and readable booklet on lac and

the research that has been done on it. The book was intended to give those interested in the lac trade, whether cultivators, manufacturers, shippers, brokers, members of consuming industries, or the general public, some idea of what had been done since the Institute was founded in 1924. It was the result of the joint authorship of the director, the entomologist and the physico-chemist.

This venture met with an immediate success that testifies to the ability of the Institute to fulfil the second part of its task—that of ensuring that its propaganda is read. The book was sold out and a second edition prepared and published within a year. Many complimentary reviews in scientific and non-scientific journals and newspapers are proof enough that the book has fulfilled a definite need. Most forest officers interested in growing of lac or in revenue from its cultivation will have seen the first edition, but we recommend that they should not be deterred on this account from obtaining a copy of the second edition. The tables of exports of shellac have been brought up-to-date and a chapter has been added to explain what lac and shellac are.

The Governor of Bihar and Orissa, who contributes a foreword, expresses the opinion that "in spite of competition from synthetic materials, there is every prospect that the natural product can continue to hold its own successfully in the world's markets." Every possible measure to ensure that the lac trade will continue to flourish is being adopted. An increase is being made in the cess on the export of shellac from which funds are obtained to finance research; a more representative controlling and advisory body is being set up; and shellac research interests in the United States, the United Kingdom and India are now working in close co-operation.

One may confidently expect that these activities will help the lac industry on the road to recovery and that forest revenues will share in the resulting benefits.

OUR ENEMY THE TERMITE

BY T. E. SNYDER, PUBLISHED BY THE COMSTOCK PUBLISHING COMPANY, ITHACA, NEW YORK, 1935. THREE DOLLARS.

Dr. Snyder of the Bureau of Entomology, Washington, U.S.A., has specialized for 26 years on the biology, classification and control of the white ants, and his technical publications are of course well-known and essential to entomologists. In his latest work, Dr. Snyder summarizes what is known of the family in a style that is so clear, that every statement can be understood by any intelligent reader. Illustrations are profuse.

The book is unreservedly recommended as the best comprehensive account of the termites *available and the only one* written in English. Among the subjects dealt with in the ten chapters are a description of the termites, as a whole, their subdivision into groups on morphological and biological grounds, description of the castes, the colonizing flight, food, types of damage and, of particular importance, a long chapter on control, in which definite recommendations, based on experience, are made.

Architects and all concerned with building will find authoritative advice on termite proof construction and methods of controlling attack in unproofed buildings. They will also find an account of the biologic groups of termites, without some knowledge of which control cannot be properly understood. It is not so trite as it sounds to point out that there are great numbers of species of termites (over a hundred in India and Ceylon) with vastly different habits. and that it is useless, for example, to try to control one species attacking the roof of a bungalow, by destroying the earth mounds of another species in the compound.

The biology and control of Indian termites still requires intensive study and this book may well be consulted by research workers in search of a subject. The scope is immense and many investigators could take up the subject without overlapping.

It is interesting to note how many instances of damage given in this book are paralleled in India. As an example, termite

damage to railway carriages in India has recently been reported to the Forest Entomologist. Guided by the very good index in this book (" Railway cars, treatment of ") we learn Dr. Snyder's prescription for controlling similar damage in Hawaii.

J. C. M. G.

PROGRESS REPORT OF FOREST ADMINISTRATION IN BIHAR AND ORISSA FOR 1934-35

The area of reserved forest under the direct management of the Forest Department increased from 880 sq. miles to 1,076 sq. miles owing to the death of the proprietor of the Porahat Estate without an heir, the forests belonging to him escheated to Government.

It is very gratifying to note that the year's working showed a substantial surplus of Rs. 1,68,435 against Rs. 16,752 in the previous year, and it looks as if the days of depression are now over, and it is therefore hoped that in future Government will make more liberal grants to the Forest Department for the improvement and extension of communications. Owing to financial stringency this work had been neglected in the past. The report rightly points out that want of facility for the extraction of forest produce re-acts on the forest revenue.

The revision of two very important working plans was completed, that is, the Saranda and Kolhan Divisions, in addition to two working plans for private forests. A perusal of Appendix III-B dealing with area statement under working plans will show that everything possible is being done to keep this very important branch of the department's work up-to-date.

Great stress, and quite rightly too, is laid on the necessity of carrying out cultural operations in areas under concentrated regeneration. These must be carried out as regularly as " clockwork " separately, at specified periods in a concentrated manner, over definite sections by a party under a subordinate, on a fixed programme, if young regeneration is to be properly assisted. Such

a scheme has been drawn up for Saranda Division and the intention is to extend it to other divisions also as the time goes on. Results to date are reported to be highly satisfactory. It is noted that creeper cutting is done in the rains. There are no true afforestation schemes, but experimental afforestation on bare rocky hills was tried. "The method employed in the area which was reputed to be incapable of growing anything was to dig contour trenches to prevent wash and catch and hold-up water falling on the slopes." This method is reported to have given good results so far, and sissoo cuttings, and teak root and shoot cuttings, give best results at present.

The need for proper control of forest produce has been felt for some time, and it has been decided to enforce transit rules in a small area at first to enable the authorities to judge how the rules will work in practice. It is understood that the question of the introduction of transit rules in Bihar and Orissa had been under discussion for a long time, and it is pleasing to note that a start has now been made.

The Conservator observes that the average gross rental paid by the forests of Bihar and Orissa during the year was Re. 0-7-0 per acre, and the net rental Re. 0-1-0 per acre, and he further says that this compares very favourably with the rent obtained for land of the quality which constitutes our forests. It would seem that the settling of land for cultivation of very bad quality is not a sound proposition, and is a question well worth study from the point of view of rural economy.

One of the most important items of work in hand at present is the reservation and leasing to Government of important and compact forest areas belonging to private owners. It is reported that most of the bigger forest areas have been taken up, and the forests which remain belong largely to small landlords who are less easy to get at and deal with. The Forest Department is to be congratulated on the success attained in this direction.

The great need in these democratic days is propaganda, and the Forest Department is trying to do this by giving lectures, by

the establishment of nurseries in rural areas, and by publishing articles on forest matters in the press occasionally. Articles on forestry are being included in the teachers' handbook and another is to be included in the children's primer.

L. R. S.

DIE FOREST BENUTZUNG

(Forest Utilisation)

(13th Edition in German Language)

A TEXT-BOOK AND HANDBOOK

By

Dr. Karl Gayer

(Late Geheimer—Rat and Extraordinary Professor in the University of Munich)

Rewritten By

Dr. Ludwig Fabricius

(Extraordinary Professor of Silviculture and Forest Utilisation in the University of Munich, Germany.)

(Publishers :—Paul Parey, Berlin, S. W. 11.)

(With 448 text illustrations and two colour plates; 748 pages; size 8vo.; bound, Marks 34.)

(The price of the book has been reduced by 25% for sale in all countries other than Germany, so that it costs in India only 25½ Marks instead of 34.)

Karl Gayer's book on Forest Utilisation, which appeared for the first time in 1863, pictures in a scientific manner, the utilisation of "Forest Produce" in the most comprehensive sense. "Wood" being by far the most important Forest Produce, has been described with all its exceptional qualities as a raw material, but its draw-backs and flaws have also been pointed out. The requirements of the wood-cutter and his working implements have been clearly described, after which are detailed the methods of felling proper, and the conversion of the felled wood for use. Then follows its utilisation into half finished and finished products in numerous

workshops, factories, saw-mills, cellulose factories, paper and artificial silk factories, wood gas and wood sugar plants, and many other industries.

The presentation of the contents has been attempted on rigidly scientific lines, but this does not denote that the book contains a lot of complicated foreign expressions which the non-specialist cannot understand, but indicates that the work is compiled according to a well laid out plan, with simplicity of style, and lucidity of construction, and avoids all technical expressions which the layman cannot understand, or otherwise explains their meaning, and especially attributes all phenomena and occurrences to their cause in a manner which every one can understand. This book can therefore help and educate not only the trained forester, but also the student, the forest owner and everyone who deals in wood and its products. It handles on a very broad basis the complete utilisation and the highest form of improvement of the raw product, "Wood," as well as the "Minor Forest Products" to the extent of pointing out their many-sided significance in the political economy of the nation.

REPORT OF THE FOREST DEPARTMENT OF THE UGANDA PROTECTORATE FOR THE YEAR 1934

The Uganda forests (1,916 sq. miles) constitute about 2·38 per cent. of the total land area of the country. They are, besides large tracts of savannah that are fast disappearing before agricultural clearing and bush fires, full of mature and overmature trees, where the right policy, as advocated, is to sell them and re-invest the proceeds in establishing better crops. After a series of experiments, the administration is now confident of its ability to raise natural-*cum*-artificially healthy crops of the required species, and justifies the increasing rate of timber-cutting disproportionate to the small forest areas. Although the Protectorate can be congratulated on this achievement, Indian experience does not, however, permit us to share this bold optimism of over-cutting, especially in view of the common injuries from annual bush fires, *iroko-gall* and mahogany

shoot-borers, which are admitted to be serious economic pests to young plantations.

Iroko (*Chlorophora excelsa*), African mahogany (*Khaya anthotheca*), *Musisi* (*Moesopsis eminii*) and *Eucalyptus* (*robusta* and *rostrata*, etc.) are the principal marketable indigenous species that are being raised in plantations. Artificial regeneration was unfavourable in 1934 on account of low and unequally distributed rainfall. Three to four-year-old *Eucalyptus* plantations have been successfully underplanted with *iroko* seedlings and stumps, the best results being obtained from fairly large stumps. Some of the above species and *Casuarina cunninghamiana* (in sandy soil) are being extensively used in afforestation as an anti-malarial measure, and also by the Municipal and other administrations in swamp and waste ground.

The nursery statement of having raised 1,705,940 plants during the year, of which 1,041,741 were planted out, 98,192 issued free or sold, and 83,549 died or thrown out, is interesting.

The manufacture of artificial manure from grass, hedge trimmings, etc., at the nursery proved a great success in bricked and cemented pits. Alternate layers of cotton seed are now being introduced in the pits—these are reported to accelerate decomposition considerably.

Improvement in methods and results of forest exploitation by private enterprise was fostered by the department and the output of timber rose by 30 per cent. An Ordinance and Rules to control the export of timber and to provide for grading were prepared in consultation with the timber trade and came into force towards the end of the year. Co-operation between timber trades for the better organisation of marketing made progress, and a " Co-operative Timber Association " is in formation. It must be admitted on all hands that " some such body is certainly required to stop the suicidal price competitions."

The statistical statements at the end of the report are only for the year under review. This could be improved upon by the addition of figures of the previous year and an average of the last quinquennium or decade (for comparison) on the lines of Indian Reports.

J.N.S.G.

EXTRACTS

SIWALIK EROSION

A. P. F. Hamilton

To the Himalayan enthusiast the Siwaliks are often little more than a name, an 'insignificant range of foot-hills', to be crossed impatiently in answer to the call of the grander ranges beyond. On the other hand, modern geography is closely concerned with the economic values of geographical features, and to-day people take much more interest than formerly in their surroundings. It is hoped, therefore, that this paper may stimulate some further interest in the important, and perhaps notorious, part that this low range is playing in Punjab economics.

The damage caused by the great floods which periodically sweep down the Punjab rivers from the high mountains attract large headlines in the newspapers; and, though they may bring great havoc, they are, in the main, caused by unusual phenomena, such as the breaking down of glacier dams and cloudbursts, which are beyond the control of man. Yet nearer at hand, under the very eyes of the public, the Siwaliks and outer ranges of the Himalaya are being slowly converted into a source of destruction, the more dangerous owing to the insidious nature of its growth.

The object of this paper is to show how men, by misguided efforts to better their condition or under the stress of economic pressure, have contravened the laws of nature, thus meriting a punishment which only too often falls upon the heads of those innocent of the offence. The paper begins with a description of the role of mountains and forests as agents for the supply and distribution of water. A brief discussion of the geology of the Siwalik range follows, and the rest of the paper deals specifically with erosion in the Siwaliks of the Hoshiarpur district in the Punjab.

Mountains as a source of water-supply, and the role of mountain-forests.

Throughout the world mountain ranges play an important physical part in the water-supply of man. They act as barriers to the passage of winds laden with moisture received by evaporation from seas, from inland lakes, and from the land itself. The warm air currents, impinging against the mountain slopes, are deflected upwards; they are cooled, and they precipitate their moisture in the form of snow or rain.

In northern India, during the winter and early spring, depressions from the west penetrate far into the Himalayan barrier; heavy snow falls on the inner hills, but little rain is experienced on the outer slopes at this season. Snow melts during the late spring and early summer, causing a gradual rise in the rivers and streams. At midsummer the rains of the South-west Monsoon, mainly from the Bay of Bengal branch, strike the mountain barrier, and bring rain to the successive ridges south of the Great Himalayan range, where the remaining moisture is given up. The rain is partly absorbed by the soil, but the greater part, as surface run-off finds its way down through countless streams and rivulets to the main rivers, and thence down to the plains of India where it serves the many requirements of man.

Winter snowfall on bare alpine land melts and drains away slowly; but it does not require much imagination to realize what happens to *rain-water* falling on bare mountain-sides. The water dashes down the slopes with ever-increasing speed, carrying away the thin soil and discharging itself into the low-lying country with uncontrollable violence. Naked rock is left behind and the land receiving the discharge of such torrents is subject to constant floods. Fortunately for man, it is a provision of nature that certain regions of the globe are covered with forest, and mountainous country is one of them. Below the snow-line, the forest clothes the hill-sides down to the plains and controls the flow of the water from the catchment areas in the hills.

A forest consists of trees or scrub, growing together with bushes, herbage or grass and humus on a soil, of varying depth, derived from the disintegration of the underlying rock. The types of vegetation found in mountainous regions depend mainly on the amount of rainfall and elevation. They vary between wide limits, from dense fir forest to little more than grass, but all play their part as agents of protection. The chief roles of the forest are—

(1) reduction and control of surface run-off,

(2) conservation of moisture, and

(3) protection of the soil from erosion.

As regards the first of these, the leaf canopy retards the rain and breaks its force; the humus layer absorbs some moisture; and the roots of trees and shrubs penetrate the soil, make it more permeable, and increase its absorptive capacity. When the soil is saturated, surface run-off begins, but its force and speed are greatly reduced by the presence of the close-growing vegetation and humus. Steep ground and impermeable soil are conducive to the most rapid run-off and are most in need of protection from this point of view. When the protective covering is removed, for instance, by heavy grazing and browsing, run-off is accelerated, and the banks of rivers and streams may be unable to hold the increased discharge. It must, however, be admitted that floods caused by exceptional meteorological conditions cannot be prevented by forests, though the destructive effects are certainly minimized.

Secondly, the forest, by retaining a covering soil *in situ*, by increasing the absorptive capacity of the soil, and by allowing water to sink slowly into cracks and crevices in the underlying rocks, enables the mountains to function as natural reservoirs. Long after the cessation of the rains the stored water gradually finds its way down to feed the springs and the water-table beyond the foot of the hills, while a higher level of stream-flow is maintained during the dry season. Briefly, therefore, a forest-covering tends to equalize the discharge of rivers and streams throughout the year and to increase the available water-supply; removal of this covering causes floods or desiccation, or both.

Thirdly, forests, by breaking the force of falling rain, particularly where heavy storms are frequent, by binding the soil with their roots, and by reducing the erosive action of run-off, prevent the erosion of hill-sides.

Erosion begins with the removal of the vegetable covering. There are two types of erosion, both of which are in evidence in any one locality but, according to the nature of the soil, one or the other is generally predominant. "Gully"

erosion originates, as its name implies, from the formation of small channels by water action; the channels deepen and cut back into the hill-side producing the well-known "ravine" lands which are as common in bare undulating country as in more mountainous regions. "Gully" erosion is most active in heavy, coherent soils, such as clays and marls, less so on sandy and friable soils, and least of all on stony ground derived from conglomerates.

The second type of erosion, "sheet" erosion, implies the removal of soil particles by the flow of water over open surfaces rather than in channels. This form of erosion acts on all surfaces which are not protected by close-growing vegetation or a humus layer. Loose and friable soils, such as sandy soils and sand-rock, are the most liable to "sheet" erosion. These coarse-textured soils maintain a smooth or rounded configuration under the action of water.

When slopes are steep and the soil and underlying rock of a friable nature, when the forest covering is scanty or absent and rainfall heavy, erosion may reach colossal proportions and the degradation of the hills is accelerated by the occurrence of landslips.

Erosion may be harmful in the following ways:

(1) The products of erosion are carried down by flood, and deposited over low-lying country which is thus rendered sterile. Desiccation, caused by the adverse hydrological effects described above, is increased by these deposits.

(2) Irrigation works and canals may be silted up, and the fields, which were formerly enriched by annual deposits of fertile soil derived from the protected slopes, now receive only a coarse, sandy deposit.

(3) Erosion increases flood height, for the detritus carried down by the water swells the stream volume to such an extent that the height of the water is raised far above what it would be if it were free from sediment. The effect of this may be gauged from figures calculated by a French expert who, for a certain mountain torrent, computed that 85,020 cubic yards of water brought down 221,052 cubic yards of detritus, or more than two and a half times the water volume.

(4) Silt deposition may entirely fill up a river-bed and so cause constant flooding; or at least the bed may be so raised that over-topping of the banks may be caused by comparatively light falls of rain.

Regarding the effect of forests on climate, this is a matter which has been in dispute for many years and evidence is contradictory. It is possible, but not probable that forests have some effect on climate as a whole; but there is evidence, in the Terai of the United Provinces, which tends to prove that the clearing of the sal forests during the period of British occupation has caused greater extremes in temperature; and there is little doubt that forests increase local precipitation both in abundance and frequency and that this effect is likely to be greater in hot, dry climates and in mountainous regions. Vegetation, by cooling the air both in and around it, also increases the condensation of moisture in the form of dew and clouds, reduces radiation, and prevents the evaporation of moisture from the soil by hot winds. The removal of forest covering, therefore, tends directly to increase desiccation.

Modern opinion is in general agreement that in countries consisting of hills and plains, the fertility of the plains, and with it the prosperity of the people, depends largely on a regulated flow of water from the hills, and that there is a direct relation between hill vegetation and floods. There are few mountain ranges outside the polar regions which, below the snow line, were not covered with vegetation before man began his work of destruction. Examples of the evils caused by disforestation can be quoted from earliest history.

Ancient Babylonia was once a fertile land watered by a vast irrigation system. Invaders may have destroyed the actual irrigation works ; but the civilization of Babylon was more certainly destroyed by fire and axe in the hills to the north whence came the " waters of Babylon." Agents of destruction far greater than invaders were let loose upon the country, transforming it into the desert of which the greater part remains to the present day.

In France, up to the time of the Revolution, the forests were under the protection of powerful landlords. When they fell into the hands of the peasants, rapid destruction took place. In a short time floods from the denuded hills caused terrible havoc to villages and cultivation below, so that the French Government is, and has now been for many decades, spending huge sums on reforestation and torrent control.

In Ceylon the clearing of hill-sides for tea-planting and cultivation has led to erosion sufficiently serious to merit the attention of Government.

Examples could be multiplied, and few countries in the world have escaped the evil results of forest destruction, but the fertility of Egypt, unchanged throughout the ages, is due to the river Nile which has its source in the forest-clad mountains of Africa, beyond the reach of civilization.

Siwalik Geology and the Nature of Chos

The Siwalik range skirts the Himalaya almost without a break from the Indus to the Brahmaputra, a distance of about 1,600 miles. Topographically the range belongs to the hills, geographically to the plains ; for although its upheaval coincided with earth movements in the Himalaya, the latter were raised early in Tertiary times, while the Siwalik rocks are composed of sediments brought down from the rising ranges to the north. These fresh-water sediments have been laid down along the front of the Himalaya ever since they started to rise. They fill what is known as the Indo-Gangetic " deep " or depression, and the recent deposits still in process of formation along the foot of the hills are their direct successors.

The Siwalik range, therefore, is composed of rocks similar in nature to those underlying the plains of northern India and the range marks the northern limit of these fresh-water deposits. It is remarkably uniform in character throughout, and though in some places it is pressed against the outer ranges of the Himalaya and not easily identified, it is more often separated from the latter by valleys, such as the " dun " valleys in the United Provinces and the Kangra valley in the Punjab.

The most important lithological character of the rocks is their lack of consolidation by geological pressure, certainly in those strata which lie exposed. The beds are stratified, and consist of loose, pebbly conglomerates, soft-earths and barely coherent sand-rock. In the Hoshiarpur Siwaliks the sand-rock predominates and is exposed in massive beds, often several hundred feet thick. Narrow beds of clays, earths, and gravels are frequently associated with the sand-rock; wherever the strata are inclined by folding, these soft beds have been eroded and the sand-rock projects in a confused array of sharp points and steep ridges. Where the conglomerates occur they overlie the sand-rock, forming shallow beds of loose pebbles.

If the Siwaliks form only a small proportion of the catchment areas of the great Punjab rivers they are, owing to the nature of their rocks, liable to contribute a large quota of silt when the other factors, favouring erosion, are present. Moreover, particularly on the southern slopes, they border cultivation for the greater part of their length and are bound to have a considerable hydrological effect on the adjacent lands. East of the Jumna river, owing partly to sound forest policy and partly to a moister climate, the Siwaliks are well covered with vegetation; but in the Punjab all the conditions favourable for rapid run-off and erosion are present. Owing to a lower rainfall and to a type of monsoon weather characterized by heavy storms succeeded by bright intervals, the conservation of water in the hills and a steadying of the river discharges are most urgent.

In the Hoshiarpur district, in particular during the last eighty or ninety years, immense damage has been caused by the disforestation of the Siwaliks, and a brief history of how it originated is given later. The damage has mainly been caused by torrents, locally called *chos*, which sweep down from the southern slopes of these hills during the monsoon.

The true torrent is characterized by the steepness of its gradient and the violence and irregularity of its discharge. As a general rule the channels are dry except at times of rainfall, when sudden and short-lived floods develop as a result of uncontrolled run-off. When hill slopes are denuded of vegetation, torrents may result from severe "gully" erosion, or streams, previously harmless, may be transformed into torrents. The amount of damage done may be very great, but it depends on a large number of considerations. Inside the hill tract velocity is maintained and the flood carries much material in suspension; even small boulders and stones may be transported, but at the point where the torrent debouches from the hills an easier gradient is encountered, velocity is reduced, and the heavier material is deposited in a characteristic fan-shaped mass called the detrital cone, or *cone de déjection*. The shape is due to the fact that the water is discharged along the top of a slowly rising convex bed formed by the detritus and is obliged to flow off in all directions, extending the "fan" on all sides and increasing the radius of its damaging effects. In the earlier stages of its formation the convexity of the detrital cone is usually more marked, but as it spreads this feature becomes less evident, the velocity of the flood is reduced and the rate of extension of the cone is retarded, while floods in the country farther afield may become less violent. Thus if a curve of torrent activity could be drawn it would show that a peak is reached in the earlier stages; the curve would then gradually fall and finally run more or less level.

The behaviour of the flood and the damage it may do farther out must be considered. If from the beginning, the water finds, or can make, a definite channel which it can deepen, little damage to the surrounding country by flooding or silting may result, but the chances of its doing so depend mainly on the following factors:

(1) the lie of the land,

(2) the nature of the soil,

(3) the amount of sediment in suspension,

(4) the velocity of the current, and

(5) the final destination of the torrent.

The water naturally follows lines of greatest declivity and of least resistance; the lie of the land can either help the torrent to pursue a single channel or may force it to spread over the country. Firm soil, by providing stable banks, favours the first alternative, loose sandy soils favour the latter. The greater the amount of matter in suspension and the more sudden any reduction in velocity due to change of gradient at any point, the more silt is deposited; this either fills up any existing channel or prevents the current from making a new one. Apart from the silt factor, the faster the current the more easily it cuts out a channel for itself. When the torrent flows down a gradually decreasing gradient which ultimately leads to flat ground, it finds no exit, flow finally ceases, and the whole of the products of erosion are deposited either in the bed of the torrent which must gradually rise or, by inundation, over the surrounding country. For the most part the Hoshiarpur Siwaliks have a gradual slope from the edge of the plains to the crest, a rise of 600 feet to 800 feet in from three to five miles, and externally they appear unlikely to cause serious torrents. Owing, however, to the effect of water action on the soft rock, deep nullahs and ravines have been carved out of the hills, and the hill topography is characterized by steep, often precipitous, slopes and gorges. The main drainage channels are fed by numerous precipitous side-streams, and, on the upper slopes, by a network of converging feeders, which give to the channels catchment areas of a size and shape out of proportion to the external features of the range.

The *chos* and their main feeders have indeed been cut to such a level by erosion that one may leave the practically flat stretches of sand in the plains, and walk from two to four miles along the *chos* within the hill boundary without any perceptible change in the gradient. Levelling a *cho* of average size over a distance of two and a half miles showed an average gradient of less than 1 per cent. (50 feet in a mile). This peculiarity distinguishes *chos* from true torrents. At the point where the *cho* debouches from the hills the detrital cone is hardly noticeable, though most *chos* show a slight convexity at the centre of the sandy bed. At one time it was probably more marked, for after issuing from the confines of the hills, *chos* spread out to form expanses of sand which, in extreme cases, are nearly a mile wide.

The country subsequently traversed by the *chos* is best described as "plains"; it is largely cultivated and the soil is sandy. The original drainage channels rapidly silted up when hill erosion and flooding started, with the result that the floods have been forced out over the country and numerous branches have been formed.

The branches of adjacent *chos* frequently unite forming a network of sandy beds which stretches for about twelve miles into the plains, and conditions shown in the map (*not reproduced*) are typical of the country within a few miles of the hills. This network condition gradually becomes less marked with increasing distance and the beds narrow down and finally die out at distances of from 15 to 25 miles, as the crow flies, from the foot of the hills.

Without exception *cho* beds in the plains are broad rivers of sand with a very slight fall. Banks are often non-existent or, at the best, composed of unstable sand liable to be washed away by any flood, or of scarped cultivation which is being undercut by every flood. The various factors affecting torrent action and the harmful results of floods in general have already been discussed; and to show that these *chos* cannot but have a most destructive effect on the lands which they traverse, it is only necessary to add that conditions in their catchment areas are most favourable for very rapid run-off and erosion.

The question may be asked how it is that with so slight a gradient the *chos* have been able to acquire sufficient force to do so much damage. The rush of water across the plains has to be seen to be believed, and the explanation is to be found in the topography of the catchment areas and the barren nature of the slopes, both of which combine to discharge into the plains, suddenly and under great pressure, an irresistible flood of water and sand. The flood subsides as suddenly as it starts and the immense volume of water, much of which might have been stored in the hills and sub-soil of the plains, is lost.

There is reliable evidence that about 100 years ago the *chos* ran between well defined banks, and that in some places perennial streams, which were used for irrigation, issued from the hills. To-day, except for floods, they are dry throughout the year. No accurate measurements have been made, but observation shows that many beds are gradually rising. As a result, the *chos* frequently change their courses so that, apart from the fact that sand is a most unfavourable medium for constructing banks, the training of *cho* floods in their present state of violence becomes an engineering impossibility, except perhaps, at a fabulous cost.

Such is the nature of the notorious Hoshiarpur *chos*. From the eighty miles front of the southern slopes of the Siwaliks nearly a hundred such torrents discharge their floods into the plains; and enough has been said to show that no half-measures will be of any avail in controlling them.

History of the Hoshiarpur Chos

During the Moghul *raj* the Siwaliks were in the hands of chieftains whose duty it was to protect the rich lands of the plains from invasion from the north. At that time the forests were strictly preserved in the interests of sport. Later, under Ranjit Singh's rule, the Rajput and other chiefs who were granted *jagirs*, appropriated all the land for their own use: the peasants, who previously had sufficient land to live on, were now compelled to seek a livelihood by grazing cattle and by cutting and selling wood from the forests. From this time the destruction of the forests began, but the inroads made were not very serious. In 1852 the first Land

Settlement under British rule was made. As there were no records of land tenure and many of the Rajput chiefs had been dispossessed owing to their hostile attitude to British intervention, almost any one who claimed possession was granted it. The result was that the Siwalik forests became the property of countless irresponsible petty landlords.

Under British rule an era of prosperity and development began. Population increased, railways developed, cantonments were established, and the demand for fire-wood and charcoal was greatly extended. The improvident landlords wasted no time in getting what they could out of their newly acquired property ; large areas of forest land were leased out for a few rupees to contractors who had a free hand to fell all the trees they liked. Cattle-herding, formerly a rather chancy source of livelihood, now became safe and profitable. Herds were grazed on the hills in increasing numbers, and goats in particular, swarmed everywhere, eating down all shrubs and bushes and preventing any fresh growth from developing. In less than thirty years destruction was complete, and, to quote from a report of Mr. Baden-Powell, Conservator of Forests, made in 1789, "So great has been the destruction that one may march for miles and miles with nothing in view but mud-coloured crests and rugged slopes, rarely dotted with greyish, browsed-down bushes. . . . ."

For many years previous to this report the *chos* had been rapidly increasing in violence. Local officers had made it clear in reports that this was due to disforestation and that the damage could only be stopped by preventing the further destruction of the vegetation and by taking steps to reforest the hills. But it was not until 1902, when the worst of the damage had been done, that effect was given to legislation designed to stop the evil.

About this time exhaustive inquiries were made to estimate the damage which had been caused by the *chos*, and it is convenient to summarize the results here.

Loss of cultivation

The area in acres under *cho* beds at three successive settlements in the Hoshiarpur district were as follows:

1852	1884	1897
48,206	80,057	94,326

Thus losses increased by almost 100 per cent. in forty-five years. In addition about 26,000 acres had been partially damaged. In the Jullundur district 2,600 acres had been completely, and 1,500 partially, destroyed. Many houses were washed away and an uncalculated area of grazing and forested land destroyed. The fertility of surrounding fields had been reduced by deposits of wind-borne sand.

Financial loss to villagers

It was calculated that in the two districts, between the 1884 and 1897 settlements alone, the land value of the thousand odd villages affected had decreased by Rs. 20 lakhs as a result of *cho* action. The indebtedness of these villages amounted to Rs. 96 lakhs, a large proportion of which was directly due to loss of land.

Losses incurred by Government

The annual loss in Land Revenue due to *cho* action must by now have reached a large figure and many grants of land in irrigation colonies have been made to those who had suffered most heavily.

From records it seems that *cho* activity reached a peak before 1897 ; figures collected in 1913 show that the rate of destruction of cultivated land had fallen off since 1897. The causes of the decline are—

(*i*) *cho* activity reached a peak before 1897 ;

(*ii*) on account of (i) the force of the floods has since been partly spent on land already devastated ;

(*iii*) decrease in rainfall ;

(*iv*) protection in the Siwaliks, to a very small extent.

Detailed examination of records and of the state of catchment areas and *cho* beds indicate that for some years *chos* have followed a more or less constant level of destruction, and this is likely to be maintained until improvement takes place in the catchment areas.

Official records show the area of land actually under *cho* bed at any one time ; they do not give the large areas of sandy waste previously destroyed but not now lying under torrent influence. The total area destroyed since the beginning can only be estimated, and is probably not far short of 150,000 acres. Some reclamation has been effected, but in this connexion the following passages taken from official correspondence reveal the true situation :

"land reclaimed from *chos* is always of poor character . . . and eventually falls back, as a rule, to an unculturable condition" . . . and

"the action of the *chos* tends to the constant diminution of the area of the good land, and every such diminution must, in a tract so thickly populated as that in question, cause the prosperity of the people to decline."

So far only the more obvious damage, that of the floods, has been considered ; earlier in this paper it was stated that disforestation of hills may have other reactions which, though they may be less serious at first, are likely to be more widespread in effect in the long run.

The water-table in the Hoshiarpur and Jullundur districts has been slowly but steadily falling in past years. This was investigated and reported on in 1931 by Mr. G. de F. Cotter, SC.D., F.G.S., Superintendent, Geological Survey of India. He attributed the fall to—

(*a*) decrease of rainfall, perhaps partly caused by disforestation ;

(*b*) increase of wells used for irrigation ;

(*c*) drying up of the river Beyn, as a result of (*a*), and also probably through disforestation of the Siwaliks.

That the rainfall in the Hoshiarpur and Jullundur districts has declined in recent years is shown by the following figures:

Average annual rainfall from—	*Inches*	*Station*
1862—82	36·70	Hoshiarpur district
1883—90	..	Not available
1891—1900	34 45	Average of Hoshiarpur and Jullundur
1901—10	31·58	,, ,, ,, ,, ,,
1911—20	28·71	,, ,, ,, ,, ,,
1921—30	26·61	,, ,, ,, ,, ,,

This decline has undoubtedly affected the water-table, but what is the cause of the decline? Statistics supplied by the Director-General of Observatories, India Meteorological Department, show that rainfall has not decreased in the Punjab generally during the past forty years. The possibility, therefore, that the decrease in these two districts may be due to local causes cannot be ignored. The regularity with which the decrease has taken place is significant, and disforestation may be a contributory factor.

The more intensive utilization of well-water must also affect the water-table, and if rainfall continues to decrease the drain on the sub-soil water from this cause can only be aggravated. But there are, probably, other factors operating; for in a zone a few miles wide along the forefront of the Siwaliks, the fall in the water-level appears to be greatest; wells have not increased here, in fact many have dried up completely and in others the water is sinking fast. There can be little doubt that as a result of disforestation the flow of water from the Siwaliks by underground percolation into this zone has been seriously interrupted. Again, since the flow of water in the *cho* beds is confined to very short periods when the floods come down, little water is able to percolate into the sub-soil. This factor might operate at a greater distance from the hills than that of underground percolation, and its effect would be felt more in the upper strata whence the wells draw their supply.

Mr. Cotter is not in favour of pumping; the water-bearing strata are not inexhaustible and the ultimate source of underground water is percolation from rainfall; rainfall cannot be increased at will, and the utilization of underground supplies is likely to extend. The presence of forest on the hills may or may not influence the *amount* of rainfall, but there can be little doubt that, when restored, it will eventually have the desired effect of increasing the *availability* of rainfall for utilization, by controlling its distribution from the Siwalik catchment area.

Nothing perhaps can be gained by attempting to assess the comparative effects of the various factors; the symptoms of desiccation are evident, and disforestation, the root cause, has been there for several decades.

Many attempts have been made to check the damage of the *chos* in the plains by constructing *bunds;* with a few minor exceptions, all these attempts have failed, as they are bound to; for, apart from the force of the water, there are no means of

dealing with the accumulations of sand. The fact must be faced, and experts have for years pointed out, that reforestation alone can bring any measure of relief. *Erosion and run-off can only be checked by replacing the vegetable covering.*

The legislation enacted in 1902 provided some measure of protection, and goats were evicted ; but by then there was nothing on the hills worth protecting, and the very scanty vegetation which has resulted is all that could be expected. Up to the present no provision has been made for systematic reforestation.

The first requirement is to stop the transportation of sand to the plains, the second is the formation of a forest soil under cover of a tree canopy. Owing to the geological formation erosion is mainly of the "sheet type." Sand-rock disintegrates directly into the fine particles of which it is composed, rendering it peculiarly liable to removal by water and wind ; for this reason the formation of soil is impossible except under the most favourable conditions. The presence of scattered trees and bushes has had little effect on surface erosion and none on soil formation. To build up a forest of trees and shrubs will take a long time and it is essential to find a counter-erosive which can both rapidly and cheaply cover the huge area which has to be dealt with. There is only one answer to this, it is *grass*. A close grown crop of grass has a considerable effect in reducing "sheet" erosion. Sand-rock can support an excellent crop of grass which extends rapidly if closed to grazing. At present the large herds of cattle that roam over the hills effectively prevent grass from spreading ; they destroy tree seedlings and at every step they break off and powder up the friable sand-rock, thus adding enormously to the amount of material to be transported by the floods. The first step is, therefore, to extend a system of closure over as wide an area as possible. Grass will not, however, by itself, solve the whole problem ; it will not entirely prevent "sheet" erosion, it has only a very moderate effect on run-off, it is useless as an agency in the formation of soil from sand-rock, and as a hydrological factor it is unimportant. In the end a vegetable covering of grass, bushes and trees must be re-established from the plains to the watershed. The area is large and delay has increased the difficulties of reforestation ; but the task is by no means impossible and, if carried out systematically, the work will not prove costly. The evil is the result of a mistaken policy ; there is a debt owing to those who have suffered, and to those who will continue to suffer unless money is spent.

The chief obstacle to success is that the Siwaliks are the property of thousands of ignorant peasants who, although favoured by the gift of grazing-grounds far in excess of those ordinarily found in the Punjab plains, have, like most Indian villagers, consistently overgrazed them. The grass has become scanty and less nourishing, and the quality of the cattle has been sacrificed for quantity. In addition the villagers have not yet learnt that interference with their rights on the part of the Government will ultimately redound to their benefit. Other countries have had similar difficulties which they have faced by acquiring the land or buying up all rights. Apart from the heavy expenditure this would involve, there are other objections to such a policy here.

A scheme of reconstruction, working through the villagers themselves, and obtaining their co-operation, is what is required. They must realize that the

Government, far from wishing to take away their rights, is prepared to act in the capacity of an agent, where protection is sought. The eviction of goats has extended the cattle-keeping habit—an improvement ; now the villager must be taught to stall-feed his animals, feeding them on the grass which he will cut from the closures. There is no need to detail all the benefits that will result from this. Where closure was applied in 1902, the villagers are now making handsome profits from the sale of grass surplus to their requirements. Reclamation of devastated land must be encouraged so that there need be less dependence on cattle. Once the *cho* beds' sand slopes are forested there will be other sources of profit, fire-wood, bamboos, lac and *bhabar* grass.

The landlords must be made to realize that there is more profit in fodder production than in grazing half-starved cattle, that their land can produce something more valuable than a few lopped trees and bushes. They will be enriched, and both the Government and their neighbours in the plains will be benefited. This may sound too optimistic, but there are hopeful signs, and if continuous and sympathetic encouragement is given to the willing, and pressure applied to the unwilling, the task is not an impossible one. Nature will take a part in reclothing the hills with vegetation, but artificial aid will be required. This is the work of experts and cannot be done by the villagers themselves. It will take long, and continuity of action must be assured by the adoption of a well-conceived plan.

Meanwhile, owing to increasing population, there is a demand for land on all sides. This can only be met by reclamation of the wasted land. Reclamation implies, first, the restoration of the land to a condition suitable for permanent cultivation and, second, the directional training of the *chos*. Success depends, ultimately, on the extent to which the rush of water and sand is reduced. Under present conditions *cho* training is possible only to a very limited extent. There are, however, thousands of acres of sterile and partially sterile land ready for reclamation. How is it that, in past years, the villagers have done so little to better themselves? The two main reasons are:

(1) Owing to loss of cultivation the people have tended to become more pastoral, and professional herdsmen have taken advantage of the increased opportunity for grazing, often at the expense of the real owners of the land.

(2) Reclamation is a technical operation which requires organization and instruction ; it cannot succeed under *laissez-faire* methods.

Reconstruction is again the key-note. Grazing must be reduced where necessary and replaced by cultivation and fodder crops. This implies closure and stall-feeding, a system of pasture management. The poor land must be manured ; stall-feeding will help, and in the Jullundur district experiments with green manure have given good results. But huge areas have to be dealt with and nature's way is the best ; the sandy wastes must lie under a crop of grass and trees for several years ; it is believed that this is the only way that such soil can be rendered permanently cultivable. Other advantages are:

(1) Closure will indirectly improve the quality of the cattle, and the grass-crop, which can be improved and increased by sowing the most suitable species, will help to solve the grazing problem.

(2) The zamindars will derive an income from the sale of surplus grass and *shisham* trees, both of which grow readily in the sand.

(3) By leaving a few trees scattered over the fields and along the borders, the land, when brought under the plough, is protected from the drying effects of sun and wind.

This technique has been followed in many cases and has produced quite good soil, but too often good intentions have been spoilt by impatience or frustrated by the invasion of graziers.

All this the people can do themselves, but constant supervision and instruction are essential ; some landlords who are unable to protect their property from the herdsmen have sought Government protection, and no doubt others will do the same. And as more land becomes fit for cultivation, the herdsmen, who are often tenants, will tend to give up their pastoral habits.

But reclamation by closure is going to do more than this ; it will ultimately train the *chos* themselves. The surest way to form sand-banks is to fix the sand with a growth of vegetation. Reclamation and consolidation will proceed inwards from both sides as conditions improve in the catchment areas. Enterprising villagers have evolved a rough technique in *cho* training in a few minor branches. If this is improved upon and continuously and judiciously directed, the *chos* will gradually become canalized between tree-lined banks, the condition they were probably in before the trouble began.

I have dealt only with the Hoshiarpur Siwaliks. Only a very small portion of the Punjab foot-hills has been touched upon, but it is enough to demonstrate the urgency of a strong forest protection policy, in order to arrest an evil which is slowly but surely spreading throughout the length and breadth of the Punjab foot-hills.

(Republished with the permission of the Editor, *Himalayan Journal.*)

The following information is extracted from the Seaborne Trade and Navigation of British India for February 1936 :—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY					
	Month of February			Eleven months, 1st April to the end of February		
	1934	1935	1936	1933-34	1934-35	1935-36
Wood and Timber						
Teak wood—						
From Siam .. cubic tons	150	..	..	10,053	3,794	277
,, French Indo-China ,,	..	..	..	325	3,099	425
,, Other Countries ,,	..	..	5	..	..	10
Total .. .. ,,	150	..	5	10,378	6,893	712
Firewood .. .. ,,	65	12	15	709	568	440
Sandal-wood .. .. ,,	47	2	19	329	267	204
Sleepers of wood for railways .. .. ,,	..	..	..	6	..	..
Other kinds of wood and timber .. .. value	..	..	..	..	..	..
Manufactures of wood, *other than* furniture and cabinet-ware ,,	..	..	..	..	..	..
Total of Wood and Timber ,,	..	..	..	..	..	..

EXPORTS

Wood and Timber						
Teak wood—						
To United Kingdom cubic tons	841	989	4,114	12,866	22,759	34,162
,, Germany .. ,, ,,	118	244	407	1,011	1,775	4,368
,, Netherlands .. ,, ,,	10	41	34	357	443	443
,, Ceylon .. ,, ,,	35	36	278	598	781	1,240
,, Union of South Africa .. ,, ,,	812	51	220	3,062	2,713	2,888
,, Portuguese East Africa .. ,, ,,	20	68	321	319	308	1,790
,, United States of America .. ,, ,,	3	..	29	493	574	416
,, Other Countries.. ,, ,,	202	170	243	2,871	4,080	5,162
Total .. ,, ,,	2,041	1,599	5,646	21,577	33,433	50,469

IMPORTS

PRINCIPAL ARTICLES	VALUE					
	MONTH OF FEBRUARY			ELEVEN MONTHS, 1ST APRIL to the end of FEBRUARY		
	1934	1935	1936	1933-34	1934-35	1935-36
	R	R	R	R	R	R
WOOD AND TIMBER						
Teak wood—						
From Siam	16,800	..	..	9,89.449	4,14,751	26,616
,, French Indo-China ..	..	..	..	37,453	2,59,606	49,479
,, Other Countries ..	..	..	390	..	89	868
Total	16,800	..	390	10,26,902	6,74,446	76,963
Firewood	975	188	225	10,609	12,517	6,507
Sandal-wood	15,701	1,638	4,263	1,33,088	88,418	73,214
Sleepers of wood for railways	..	..	..	612	..	...
Other kinds of wood and timber	2,31,594	2,18,199	2,79,119	24,19,096	21,52,965	24,29,424
Manufactures of wood, *other than* furniture and cabinet-ware	1,09,210	2,29,101	2,16,334	13,37,291	20,90,525	23,68,781
Total of Wood and Timber ..	3,74,280	4,49,126	5,00,331	49,27,598	50,18,871	49,54,889

EXPORTS

WOOD AND TIMBER						
Teak wood—						
To United Kingdom ..	1,84,256	2,03,262	7,94,908	29,92,484	49,45,480	66,12,487
,, Germany	24,673	64,201	88,816	2,65,185	4,33,609	9,98,110
,, Netherlands	2,300	7,746	6,087	57,449	80,305	82,067
,, Ceylon	4,429	3,940	35,978	82,501	1,05,224	1,62,244
,, Union of South Africa ..	2,02,220	5,528	47,479	7,62,148	5,93,602	4,91,601
,, Portuguese East Africa	3,500	13,010	48,195	69,424	53,788	2,91,615
,, United States of America	650	..	5,982	1,10,535	1,59,212	1,00,420
,, Other Countries	34,342	31,540	50,468	5,43,749	7,85,315	9,84,934
Total	4,56,370	3,29,227	10,77,913	48,83,475	71,56,535	97,23,478

EXPORTS—(contd.)

PRINCIPAL ARTICLES	QUANTITY					
	MONTH OF FEBRUARY			ELEVEN MONTHS, 1ST APRIL to the end of FEBRUARY		
	1934	1935	1936	1933-34	1934-35	1935-36
WOOD AND TIMBER						
Teak wood—						
Share of Bengal ..cubic tons	..	..	..	7	10	21
,, Bombay .. ,, ,,	69	80	141	1,266	1,834	1,367
,, Sind .. ,, ,,	..	..	..	26	1	3
,, Madras .. ,, ,,	49	52	..	111	192	75
,, Burma .. ,, ,,	1,923	1,467	5,505	20,167	31,396	49,003
Total .. ,, ,,	2,041	1,599	5,646	21,577	33,433	50,469
Teak Keys .. .. tons	287	161	471	3,209	3,161	4,259
Firewood	16	..	8	239	132	66
Hardwood (*other than* teak)— To United Kingdom, cubic tons	47	20	57	466	535	721
,, Other Countries .. ,,	..	14	1	99	91	83
Total .. ,,	47	34	58	565	626	804
Sandal— To United Kingdom .. tons	..	..	..	254	32	37
,, China (*excluding* Hong-Kong) .. ,,	..	10	5	75	51	30
,, Japan .. .. ,,	10	5	20	108	89	112
,, Anglo-Egyptian Sudan .. .. ,,	3	4	3	47	48	65
,, United States of America .. .. ,,	..	50	50	322	388	519
,, Other Countries .. ,,	..	..	8	42	18	45
Total .. ,,	13	69	86	848	626	808
Other kinds of wood and timber .. .. value	..	..	..	..	..	..
Manufactures of wood, *other than* furniture and cabinet-ware .. .. ,,	..	..	..	..	..	..
TOTAL OF WOOD AND TIMBER AND MANUFACTURES THEREOF ,,	..	..	..	..	..	..

EXPORTS—(contd.)

PRINCIPAL ARTICLES	VALUE					
	MONTH OF FEBRUARY			ELEVEN MONTHS, 1ST APRIL to the end of FEBRUARY		
	1934	1935	1936	1933-34	1934-35	1935-36
	R	R	R	R	R	R
WOOD AND TIMBER						
Teak wood—						
Share of Bengal	..	..	..	1,500	1,430	5,341
,, Bombay	17,081	22,054	20,078	2,77,848	3,45,658	2,54,996
,, Sind	90	..	..	7,128	466	340
,, Madras	3,467	3,005	..	12,243	16,140	7,251
,, Burma	4,35,732	3,04,168	10,57,835	45,84,756	67,92,841	94,55,550
Total	4,56,370	3,29,227	10,77,913	48,83,475	71,56,535	97,23,478
Teak Keys	43,125	35,020	73,547	4,59,466	4,66,750	6,31,699
Firewood	316	..	40	3,391	2,403	887
Hardwood (*other than* teak)—						
To United Kingdom	4,752	2,092	5,899	58,022	52,605	78,222
,, Other Countries	8	1,425	88	11,835	10,089	8,982
Total	4,760	3,517	5,987	69,857	62,694	87,204
Sandal—						
To United Kingdom	..	..	..	3,01,063	39,586	42,276
,, China (*excluding* Hong-Kong)	..	13,440	7,200	1,09,606	79,265	42,690
,, Japan	5,014	6,450	21,200	1,18,828	92,869	1,21,777
,, Anglo-Egyptian Sudan ..	2,970	3,075	3,250	51,720	51,375	83,715
,, United States of America	..	50,000	50,000	4,43,345	4,48,800	5,28,090
,, Other Countries	295	150	8,608	59,943	32,978	52,276
Total ..	8,279	73,115	90,258	10,84,505	7,44,873	8,70,824
Other kinds of wood and timber	32,077	19,577	26,272	2,03,288	3,20,757	3,15,590
Manufactures of wood, *other than* furniture and cabinet-ware	24,140	9,304	12,323	1,74,353	1,09,005	95,465
TOTAL OF WOOD AND TIMBER AND MANUFACTURES THEREOF	5,69,067	4,69,760	12,86,340	68,78,335	88,63,017	1,17,25,147

INDIAN FORESTRY PROBLEM

NEW POLICIES

Sir Roy Lister Robinson, Chairman of the Forestry Commission, addressing the Royal Society of Arts on "Forestry in the British Empire," expressed the opinion that, considered purely as a forestry question, the provincialization of forests and the Imperial Forest Service in India would not be a change for the better.

The lecturer said that India had the first organized forest service and had contributed much to the spread of forestry ideas throughout the Empire.

For a number of years after the inception of a definite forest policy in Lord Dalhousie's Viceroyalty (1855), forestry developed steadily. The higher technical staff formed a unified Forest Service (Imperial Forest Service) recruited and trained in Britain and on the Continent of Europe. The settlement of forest areas—the necessary prelude to systematic management, the preparation of working plans and the aggregation of practical experience in handling the forest, had all made good headway up to the time of the Great War.

Further the foundation of the Forest Research Institute at Dehra Dun in 1906 marked the first effort in the British Empire to apply research methods to forestry practice. After the war the modest Institute at Dehra Dun was replaced by imposing buildings to house the forest products research work, the silviculturist and other specialists engaged on forest problems, and to provide space for educational activities. Recruitment on a large scale was begun to fill the vacancies in the Imperial Forest Service due to the lack of appointments during the War years.

RECENT SETBACK

By these means great progress was being made in bringing the forests under systematic management and in improving forest technique, but the early post-war activities were gradually falling away. Recruitment from Britain was first reduced and then stopped; training for forest officers was started at Dehra Dun and later stopped. The forestry activities of the Government of India declined and the responsibility for the forests had leaned towards the provinces.

These changes were but part of the great constitutional changes which were under consideration for India as a whole. In the upshot the Government of India Act provincialized the foresters, and the Imperial Forest Service as such would cease to exist. The next few years were going to be a testing period for forestry in India. The individual provinces had to formulate their separate policies and to build up staffs capable of carrying out the work.

Again, our democratic forms of government were not always the best from the forestry point of view. There was a saying that "trees have no votes," and the ideal consequently would be to remove forest policy outside the realm of politics, as had fortunately been done in Great Britain. That course was not easy in newer countries, where the products of the soil were relatively more important, but it could be done if public opinion was made sufficiently aware of the dangers of unrestricted exploitation. These dangers were often very real. If forests were exploited or degraded beyond a certain point, it was a very slow and expensive process getting

them back to a state of productivity. In the meantime prosperous industries languished or decayed. If destruction of forest cover was followed by erosion, the difficulties were greatly intensified.

The theory of an approaching timber famine might or might not be true, but the importance to the human race of sound forest conservation was undeniable. Timber was a renewable crop which was satisfied with the minimum conditions of growth, while wood itself was a raw material of infinite uses, both actual and potential. Indirectly, the beneficial influences of forests were great. To sweep them away was to lay the countryside open to manifold ills.—(*Statesman.*)

PHOTOPERIODISM IN FORESTRY

BY S. R. GEVORKIANTZ AND E. I. ROE,

Lake States Forest Experiment Station, U. S. Forest Service

The study of light in relation to plant growth has long been a subject of vital interest to plant physiologists, œcologists, and foresters. In the past, attention has been concentrated entirely on the quality and intensity of light. More recently, the discoveries of Garner and Allard have shown that the duration of the daily periods of light have a profound effect upon the life functions of plants. This response to the length of continuous daylight periods is called *photoperiodism.*

This new concept already has changed the views and opinions of many plant physiologists. Although the principles have been verified by many investigators, the field is such a new one that as yet no general conclusions can be made. There is little doubt, however, but that applied plant sciences such as agronomy, genetics, œcology, and very likely forestry, will benefit a great deal once the length of day becomes well recognized as an environmental factor.

The length of day affects not only the amount of food produced by the plant, but also the manner in which it is used. This is manifested by changes in total stem length, leaf surface area, root development, branching habit, bud activity, and leaf fall. It also influences the hydrogenion concentration of the cell sap and the carbohydrate content of the plant.

Garner and Allard found that by shortening the length of day, it is possible either to hasten or to retard flowering, and sometimes to prevent it altogether. Considering the equatorial length of daylight of 12 hours as standard and the length of day for different latitudes and different times of the year as varying from 0 to 24 hours, they divided plants into three categories:

1. Short-day plants—those able to bloom only if the daylight period is less than 12 hours.
2. Long-day plants—those requiring more than 12 hours for this purpose.
3. Everblooming plants—those indifferent to these limits.

PHOTOPERIODISM IN FOREST TREE SPECIES

Although some little work has been done with agricultural plants, very little information is as yet available as to the effect of length of day on forest trees. The

scientific control of light duration experiments with large trees is very difficult, but young seedlings lend themselves to such investigations equally as well as field crops. Although Garner and Allard used box elder, tulip poplar and sumac, their main interest was in agricultural plants.

The recent investigations by Moshkov (5) and Bogdanov in Russia show interesting results concerning the reaction of seedling trees to varying lengths of day. Both workers conducted their experiments in the vicinity of Leningrad, where the length of day reaches 20 hours on the 21st of June. Light-proof boxes were used for the experiments. Besides the control beds exposed to normal day length, Moshkov used 10-, 12-, and 14-hour light periods; Bogdanov, 9- and 13-hour periods. Precipitation obstructed by the boxes was supplied artificially, all other conditions remaining uniform. One and 2-year old seedlings of several species of the following genera were used: *Acer, Aesculus, Ailanthus, Alnus, Caragana, Corylus, Fraxinus, Juglans, Larix, Phellodendron, Pinus, Prunus, Pyrus, Rhus, Robina, Salix* and *Ulmus*.

Growing season.—According to Bogdanov, all species studied had their vegetative period shortened by decreasing the length of day. The short day caused premature cessation of height growth, more rapid hardening of young shoots, and earlier leaf fall. As a result, the seedlings matured earlier and became more frost resistant and winter hardy than those grown under the 20-hour period. For example, *Robinia pseudoacacia* under the normal Leningrad day (20 hours) does not finish its growth and is frequently damaged by fall frosts, but when 14- and 10-hour periods of light are used, the vegetative period lasts only eighty-three and thirty days, respectively.

The maturation of shoots and leaf fall show the same general trends, most species completing their growth only under the 10-hour day. Shortening of the light periods when delayed until mid-summer produced the same effect as when the plants were subjected to it throughout the growing season.

Yearly growth.—The combined length of all shoots does not necessarily decrease in all species with the decrease in the length of day. *Larix sibirica, Robinia pseudoacacia, Salix bicolor*, and others showed the best growth of shoots under the Leningrad conditions while *Salix babylonica* and *Pyrus ussuriensis* showed the greatest growth under the 14-hour period. This clearly indicates that different plants must have different photoperiods for optimum development.

It was also found that in some species an exposure to short light periods tended to exert its influence even after the plants had been previously exposed to long periods of light. For example, Moshkov found that when plants of *Phellodendron amurense*, grown under long-light periods for one year, were shifted the second year to short-light periods, they responded in the same manner as those subjected to short-light periods during both years. When, however, short-day plants were exposed to long-day conditions the following year, they showed a decrease in growth compared to that made by plants grown under the long-light periods for both years. This leads him to the conclusion that the shortening of the light periods, if necessary, could be started one year or more after seeding.

Development of secondary shoots.—The length of day was found to influence the development of secondary shoots, or the new growth developing from buds of the same year. Thus many pine seedlings from southern Russia grew two shoots a year under the Leningrad day, but only one when short-light periods were used. Under the latter periods buds opened up from five to ten days earlier in the spring than under the long-day conditions.

Morphological changes.—Interesting morphological changes were caused by shortening the daylight periods. These included such things as branching habit, colour and structure of leaves, appearance of thorns, size of cells, thickness of cell walls, root development, and starch accumulation. These effects were so marked that cuttings of the same parentage when grown under identical conditions, save the length of light periods, could be mistaken for different forms or varieties of the same species.

Salix babylonica plants, grown under 20-hour conditions, produce 74 secondary branches, while under 14-, 12-, and 10-hour periods only 57, 47, and 16 per cent. of this number. The 20-hour plants had narrow-lanceolate, light yellowish-green, thin leaves; the 10-hour plants had broad lanceolate, dark green, leathery leaves; the other plants developed leaves intermediate between these extremes. Black locust showed not only marked differences in branching habit and the colour, shape, and texture of its leaves, but also in the shape of the transverse section of shoots, size of thorns, shape of roots, and their starch content.

Frost resistance.—The Russian investigators also found that subjecting plants to short-day periods increased their frost resistance. This is a very practical feature, for it implies that the use of certain species in northern latitudes is limited, as under the longer daylight periods the plants will not mature before the fall frosts. Black locust from Caucasia had only four per cent. survival under the 20-hour day, but complete survival under the 12- and 10-hour periods. Apricots from southern Caucasia were completely killed by frost under the normal Leningrad day, but under 10-hour conditions only the upper parts of shoots were frozen. In general, the more northern the origin of the plant, the less shortening of day it required to become frost resistant. In the introduction of exotic plants, therefore, one must consider, in addition to climatic factors, the normal photoperiodic requirements of the species in question.

According to Moshkov, the northern species such as *Salix bicolor* and *Larix sibirica* are frost resistant under Leningrad conditions. He believes that they should be cultivated in the north and not in the south, where the days are short. He does not subscribe to the common belief that when these species are brought into the south they will grow faster than in their native habitats.

Species such as *Salix babylonica* and *Pyrus ussuriensis* are not frost hardy in the vicinity of Leningrad and should be grown in the south, since it is not feasible to shorten the days in a northern latitude. When subjected to the northern climate and its attendant long days, these species do not complete their hardening and are injured by frosts.

Practical considerations.—From these experiments it is evident that the duration of daily light periods is an environmental factor of considerable importance, a factor

that must be taken into account by foresters as well as agronomists. The practical significance of this relationship cannot be fully recognized or appreciated until more research has been done. However, many grave mistakes can be avoided by a knowledge of photoperiodism, and some of the more puzzling problems can be cleared up once its principles become thoroughly understood.

The length of daylight periods may possibly have some bearing on drought resistance of plants, but as yet nothing definite is known about this important characteristic. Similarly, tolerance of forest trees to shade may possibly be connected with the length of day.

Additional studies of photoperiodism in forest tree species should be made. While waiting for the results of these studies it would be highly advisable to use great caution in shifting plants out of their native habitats, especially where any great difference in latitude is involved.

(Journal of Forestry.)

INDIAN FORESTER

JULY, 1936

THINNINGS IN COPPICE CROPS

BY J. W. NICHOLSON, I.F.S.

Dr. Gorrie's article on thinnings and Mr. Laurie's note thereon, both of which were published in the March number of the *Indian Forester*, have initiated discussion of a problem which must be of interest to most forest officers in this country. For many years I have held the opinion that the grades of thinning officially adopted in India have been based too much on European practice and that they are unsuited for mixed hardwood crops of coppice origin. As the area of such crops in India comprises a very considerable percentage of the total area under forest management, they merit special consideration. Any forest officer who attempts to apply any of the official grades of thinning in such coppice crops soon realises that he has to divorce field practice from paper theory. There are two or three factors in particular which give rise to complications not catered for in the official grades. One is the large number of species which usually have to be dealt with and the small economic importance of most of them. Another is the fact that it is almost impossible to create those permanent gaps in the canopy which form such a grim bogey in European practice. A third factor is multiple production of shoots from stools. A fourth factor, and a very important one indeed, is that under large scale thinning operations in crops of no great potential value, thinning rules and grades must be sufficiently simple for a forest guard of average intelligence to carry out satisfactorily.

Fifteen years ago I drew up a working plan for one of our Orissa divisions. The plan embodied two features which were unusual at that period. Firstly, it contemplated that good timber could be grown from crops of coppice origin and so introduced much longer rotations,

up to 60 years, than had hitherto been customary in the province. Secondly, it realised that coppice crops required just as regular thinning as crops of seedling origin. Thinnings were therefore prescribed at regular intervals of 10 years, starting at an age of 10 years in good, and 20 years in poor quality, forest. When I came to apply one or two of the grades which had been accepted at the Silvicultural Conference of 1918, I found myself up against practical difficulties. In the enthusiasm of youth I therefore cast down the Dehra Dun idols and drew up my own classification of thinnings. This classification could not however be fully tested in the field owing to lack of suitably aged crops in which to execute thinnings, and in the light of further experience I now realise that it was far more complicated than was really necessary.

A few months ago I was reposted to the charge of the same division, or rather, of part of it as it had since been split into two divisions. My working plan had been revised by another officer. He recognised the value of thinnings in coppice crops and prescribed that they should be done in all crops at intervals of 10 years, from an age of 10 years. Having been schooled in the Dehra Dun hierarchy, he considered that the original working plan officer had been guilty of abominable sacrilege and he therefore decided to restore the idols so impetuously hurled down. It was prescribed that the tree and the thinning classification adopted by the Silvicultural Conference at Dehra Dun in 1929 should be followed with the addition of a special "P" grade stump thinning suitable for coppice crops aged 10 years, the latter being regarded as an unavoidable lay addition to the hierarchical laws. Alas, however, for these good intentions. His worship proved too blind, and instead of detailing the grades which were accepted by our silvicultural pundits at the conference mentioned, he detailed those which were set forth on pages 222 to 225 of the proceedings and which had been rejected as being too complicated even for research workers in pure crops! The special stump thinning which he incorporated was described as a "B" grade thinning which included the reduction of shoots to 2, 3 or 4 per stool.

When I took over charge of the division I was asked by my most senior ranger how one carried out a "C" grade thinning which defined that certain classes of trees should be removed gradually, seeing that in many felling series only one "C" grade thinning during the rotation had been prescribed. This was rather a poser to which I expressed my inability to reply until I had seen the crops for myself. When I came to examine the execution of thinnings under the current plan I found the silvicultural results had been tragic. The rules involved the recognition of 14 classes of trees from normal predominants to diseased sub-dominants. None of the staff knew exactly how all these various classes of trees were to be dealt with, but as control forms had to be completed something had to be done. In general, whatever the grade prescribed, the idea of the staff seems to have been to massacre all trees and shrubs in the lowest storey, leaving the uppermost canopy untouched. In open crops the soil was thus undesirably uncovered, and in dense crops the canopy was left congested and unthinned.

The sanctity which attaches to working plan prescriptions did not permit of their being promptly amended, but I was given permission to experiment with more practical rules. This I have been doing and the rules which are given below constitute the latest edition. They are based on three main assumptions.

(1) In mixed crops it is desirable in present economic circumstances to treat only certain principal valuable species and these should be encouraged against other species.

(2) Crown thinnings are the most suitable for most of our hardwood species.

(3) As natural regeneration of seedlings tends to become suppressed by regeneration from coppice shoots it is desirable, in the course of thinnings, to favour a percentage of seedling regeneration so that subsequent wastage in stools can be replaced.

These tenets may be disputable, but one must have some working hypothesis. The rules are as follows: Principal species are defined

in the plan. They are about ten in number and include: sal, *Pterocarpus marsupium*, *Gmelina arborea*, *Terminalia tomentosa*, etc.—

Rules for " A " Grade Thinnings

(1) Fell or girdle all inferior species interfering, or likely to interfere, within a few years with principal species over 6 feet in height.

(2) Fell or girdle all defective principal species except (*a*) unmarketable trees under 16″ in diameter whose coppice shoots will remain suppressed, and (*b*) unmarketable trees over 16″ in diameter which are not suppressing principal species over 6 feet in height.

(3) Fell or girdle all trees attacked by *Loranthus*.

(4) Reduce shoots of principal species to one per stool.

(5) Principal species should be thinned out so that the most promising dominant stems are left with their crowns free from interference.

Executive Instructions

1. Bamboos will be regarded as inferior species and they should be cut back where interfering with established regeneration of principal species. As a rule, they only cause interference, when the regeneration is growing very close to the base of the clump.

2. No marketable trees of any species and no principal species under 16″ in diameter should ever be girdled, nor should species be girdled which are difficult to kill by girdling, *e.g.*, *jam* and *dhobin*. *Mohul* requires severe girdling.

3. Caution should be observed in reducing shoots of principal *species to one per stool* where the *canopy is open*. For example two good dominant *sal* shoots from one stool can be left if there is a gap all round their crowns which will not close up for 10 years or more. In such cases the shoots must be equal in size. Further, in case of *gambhar* it may usually be advisable to keep more than one shoot per stool.

The following are botanical names of the trees mentioned by vernacular names on pages 400 and 401 :

Jam (*Eugenia jambolana*); *dhobin* (*Dalbergia paniculata*); *gambhar* (*Gmelina arborea*); *bija* (*Pterocarpus marsupium*); *sahaj* (*Terminalia tomentosa*); and *sissoo* (*Dalbergia sissoo*).

4. The same caution should be observed in carrying out rule (5). Two or even three principal species may be left with their crowns closely touching if there is a gap in the canopy all round their crowns which will not close up before the next thinning is due.
5. Thinning officers must bear in mind that it is undesirable to have a pure crop of *sal*, and therefore other principal species must be favoured if necessary at the expense of *sal*. Further, in some localities particular species such as *bija* are likely to grow better than *sal*, and in such cases they must be invariably favoured. Although *sahaj* is not as valuable as *sal*, a certain percentage of *sahaj* in a *sal* crop improves the chances of getting good natural regeneration of *sal*. Rare species such as *gambhar* and *sissoo* should almost always be encouraged at the expense of other principal species.

" B " Grade Thinning

Thinnings under this grade will be exactly the same as under " A " grade except that under rules (1) and (2) only principal species of sapling size or over will be favoured. This grade will be applied 10 years before final fellings, and it is not worth while favouring established regeneration over 6 feet in height which in 10 years' time will neither be marketable nor sufficiently large to reserve as standards.

The above rules are somewhat complicated by the necessity for catering for the removal of standards or large trees left standing at the time of the main fellings. For simple coppice crops simpler rules would suffice. Despite their apparent complexity I have found, however, in practice, that intelligent forest guards and coolies quickly grasp their main idea. They have not yet been tried in crops over 30 years in age.

The pundits will criticise the above rules on the grounds that they involve a species of thinning not recognised by the text-books and that they do not prescribe any definite differentiation in intensification. I quite agree. The thinning is a thinning *sui generis* evolved to meet the requirements of existing crops. It does not

pretend to be anything else. It fulfils the tenets which have been advanced above and it does result in an apparently big crop improvement. In many cases we shall greatly increase the percentage of principal species which will form part of the final crop. There do not appear to be any serious drawbacks but the more obvious ones may be referred to. Firstly, we are creating a somewhat uneven-aged canopy under a silvicultural system which is intended, standards excepted, to be an even-aged one. Opinions may differ, but I hold this to be an advantage. In any case you cannot achieve a very even canopy in a crop consisting of many different species each with its own rate of growth. Secondly, the rules involve a hard and fast line being drawn between principal and inferior species. The most valuable of the inferior species may, therefore, be immaturely sacrificed to make room for the least valuable principal species. This objection has some weight. It can be overcome by minor alterations and additions to the rules and executive instructions, but at present I am trying to keep them as simple as possible. Thirdly, there is the absence of differentiation in intensification. I started off with the idea of fixing approximate distances to which stems in the upper canopy should be thinned, but I found that I had continually to disobey the rules. By the time we have carried out rules (1) to (4) we are never left with a crowded crop of normal dominant principal species. The latter are solitary or in very small groups. I do not know whether it would be possible in fully stocked crops of principal species to lay down to what distances dominant trees should be thinned, as a standard for the marking officer, but the requirements of the principal species are so different in respect of rate of growth, shape of crown and shade tolerance, that any such guide could be only very approximate. Further, it is not merely a question of light intensity, it is also one of soil capacity and we do not know how far the maintenance of a lower canopy of trees (usually of inferior species) is going to affect the growth of the dominants. It can be tentatively assumed that by reason of the existence of a lower storey, crown thinnings can and *must* be made heavier than would be the case under ordinary thinning grades. Basal area per acre is the ultimate ruling factor.

I think I have sufficiently indicated the magnitude of the problem that besets any attempt to standardise and differentiate grades of thinning applicable in mixed hardwood crops in India. Until more suitable standard grades are evolved we must follow rules both simple and elastic which will enable us in the light of silvicultural experience to deal with the variable crop conditions which arise.

Finally, I would join issue with Mr. Laurie over his statement that *sal* is a strong shade-bearer. I do not consider this is true of *sal* coppice shoots. In my experience the latter have to be thinned fairly early and heavily if satisfactory growth is to be obtained.

NOTE BY Mr. H. G. CHAMPION,

Silviculturist, Forest Research Institute.

Mr. Nicholson has probably done more than any other officer to improve our methods of tending mixed coppice crops. The problem is perhaps a more urgent one in his province than elsewhere, but is encountered in almost all parts of India.

The fiasco he describes in a certain division is on his own showing, due, in the first place, to the unintelligent application of the wrong kind of thinning—ordinary thinning in a crop where it was desirable to retain the underwood and open up the top storey, an operation for which crown thinning is expressly designed. The mistake was rendered worse by the attempt to use rules drawn up for intensive research work. The bad results accordingly do not demonstrate anything inherently wrong in either our standard thinning methods or the rules for their application in divisional practice. It may be noted *en passant*, that the research rules referred to were not rejected as too complicated even for research workers, and are, in fact, the rules used by them to-day.

Mr. Nicholson now puts forward some " rules " for thinning mixed coppice crops (with residual standards) which require examination to see whether they will meet requirements for acceptance as a general standard for such work. The chief criterion is, that if the operation is carried out as described, by different individuals, the results should be closely similar. Read with the explanatory notes,

they should be so with the admitted exception of the by no means unimportant respect of intensity as applied to the principal species. The proposals are accordingly on the whole acceptable, but they contain nothing that can be considered a classification, and the arbitrary separation of essential clauses as executive instructions, hardly adds to their simplicity. They will read singularly familiar to those who have had to deal with the operation usually described as an improvement felling (*vide Glossary of Technical Terms*), and in young coppice in the sapling stage, are largely covered by the standard definition of a cleaning. One is also left wondering whether it has occurred to Mr. Nicholson to see how the standard crown thinning prescriptions suitably modified for a mixed coppice crop with residual standards might fit his requirements: it might even be predicted that he would not be able to tell the difference from his own proposals.

It is, of course, a commonplace that the exceptionally keen officer dislikes being bound by rules and this is particularly the case with thinning. Conditions are such that few, except those concerned in research work involving continued observation of specified tree crops, see the results of the work and have it forced on their notice how widely different are different peoples ideas of a "proper" thinning—for the keen officer referred to always, considers his own brand the only "proper" one and can rarely describe it lucidly. Research workers, in all countries, have accordingly experienced the need of a suitable tree classification as the basis of a descriptive account of the different methods and intensities of thinning. Having contributed nothing to the subject myself except some amplifications for special research work, I subscribe myself a strong supporter of our existing classification and consider that the very marked improvement in our thinning practice during the past two decades is in considerable part due to the lead given by those responsible for it.

At the risk of making this note over long, I would like to record my view that Mr. Nicholson's use of the term "A grade" thinning is highly objectionable. It is extremely undesirable to use a name which has been adopted internationally for something different. The "B" grade hardly stands in a grade or intensity relation to

" A " (Why " intensification " ?). Rules (1) and (2) only require a proviso to the effect that, if the final felling falls within the next 10 years, the minimum size to be helped is a sapling instead of a stem over 6 feet. Here Mr. Nicholson leads us into a morass. He has such a dread of standard classifications, especially if sponsored by meetings of officers who might be described as pundits, that he hasn't mentioned what is to be considered as a sapling and by so doing has provided exactly the type of illustration needed to bring out the value of a carefully-thought-out standard of reference for tree sizes, tree classes, and thinning intensities. Reference to the *Glossary* for the definition of a sapling will shew, that rightly or wrongly, the lower limit adopted for a sapling has been put at 3 feet. This figure, appearing in the 1911 *Glossary* of Messrs. Caccia and Troup, was accepted by the 1929 and 1934 Committees which included no single research " Specialist," and comes presumably none the less in the category of " Dehra Dun idols " to be cast down by any individual who doesn't like the look of it.

Although it does not appear anywhere to have been explicitly stated, the present standard classification of trees and thinning was drawn up for, and is only intended for, application to pure even-aged high forest crops. At the Silvicultural Conferences, it was recognised that we still need similar standard prescriptions for coppice crops, for young plantations and natural regeneration, and for mixed crops, as various references in the Proceedings make amply apparent. Mr. Nicholson's proposals should lead to the compilation of the necessary extension of our standards, but I do not think that in their present form they are suitable for general adoption even for the special case he is dealing with.

Note.—Mr. S. H. Howard, Conservator of Forests, U. P., is of opinion that what Mr. Nicholson has written is not a classification of thinnings; it is merely a set of instructions for marking certain types of area. The classification of thinnings merely gives certain names and says what those names mean. If any one wants to do something different from those things, there is nothing to stop them, and nothing to stop them describing what they have done. Equally, if you have

done something in a forest and it happens to be one of the operations defined in the classification of thinnings, it is shorter to use the grade name "Heavy ordinary C. Grade" than to describe it. If you have done something else, well then you cannot describe it by these names naturally, unless, of course, you want to confuse everybody. It is surely self-evident that a classification of thinnings, meant for more or less pure even-aged crops, will not cover every possible operation in forestry—nor is it meant to.—*Hon. Ed.*

ON SOME LITTLE-KNOWN AND CONFUSED INDIAN TERMINALIAS

By C. E. Parkinson,

Forest Botanist, F.R.I., Dehra Dun.

The two Indian trees *Terminalia catappa* Linn. and *T. procera* Roxb. have been confused recently in Indian botanical literature. They are both good species and the writer believes that they have been misunderstood on account of insufficient knowledge of the plants in the field or the want of adequate herbarium specimens.

T. catappa Linn. is a well-known littoral tree occurring naturally along the tropical seashores of the Indian and Pacific oceans from the Seychelles to India, Malaya, the Philippines, Moluccas and Timor. Like several other beach forest trees with which it occurs associated, such as *Erythrina indica*, *Calophyllum inophyllum* and *Thespesia populnea*, it grows well when planted inland in moist warm districts and, being a good avenue tree, it often forms a conspicuous feature of the vegetation of sea-coast towns like Goa, Madras, Calcutta, Rangoon, Mergui, etc. Its fruit, which is light and fibrous and adapted to dispersal by ocean drift, contains an edible kernel tasting somewhat like those of almonds, and on this account the tree is called the Indian, Bengal or Goa almond.

The allied tree, *T. procera* Roxb., is little if at all planted in India. It was introduced from the Andaman islands in 1794, by Colonel Kyd, to the Royal Botanic Gardens, Calcutta, of which he

was then the Superintendent; it was later described and figured by Roxburgh in Coromandel Plants (1819) and the Flora Indica (1832).

It was correctly recognised as a species distinct from *T. catappa* by Kurz in the Forest Flora of British Burma, and by Clarke in the Flora of British India, but King erroneously reduced it in the *Journal of the Asiatic Society of Bengal*, Vol. 66 (1897), p. 331, and in this he was followed by Brandis in *Indian Trees* and by Blatter in his paper on the Indian Species of Terminalia in the *Journal of the Indian Botanical Society*, Vol. VIII (1929), p. 249. It is difficult to confuse the fruits of the two species, and King's statement, that fruits with the obscurely 5-ridged peculiarity may be gathered from the same tree as those bearing the ordinary sharp-edged fruit, is not in agreement with the writer's long experience of these two trees. The ripe fruit of *T. procera* is like the edible olive, ellipsoid, smooth and circular in transverse section and never laterally compressed; in some herbarium specimens apparent compression is seen in dried fruits, but this is the result of the pressure of the botanical press; a ribbed nut, embedded in the fleshy fibrous mesocarp, occupies the central portion of the drupe. It is well depicted in Roxburgh's Coromandel Plants,. t 224; when dry, as in herbarium specimens, the mesocarp shrinks and the fruit becomes somewhat angled in appearance as is the case in some of the other species of Terminalia in this section.

T. procera is an inland, not coastal, tree occurring in the Andaman and Nicobar islands; it is an important timber tree in the Andamans where it is called White *bombway*; its fruit is not adapted to dispersal by ocean currents. The tree is also reported to occur in Cochin-China, *fide Flora Générale de l'Indo-Chine*, but the writer has seen no specimens from there nor has he seen the tree planted anywhere in India or Burma.

Some references to literature, the chief differences between the two trees and the herbarium specimens seen by the writer are given below:

T. catappa Linn. Mant. II (1771) 519; Kurz For. Fl. Brit. Burma, i. (1877) 454; C. B. Clarke in Fl. Brit. Ind. ii. (1878) 444;

Gamble Fl. Madras (1919) 463 ; Parkinson, For. Fl. Andam. Islds. (1923) 167 ; D. F. v. Slooten, Combret. Dutch East Ind. in Bull. Jard. Bot. Buitenz. (1924) 4.

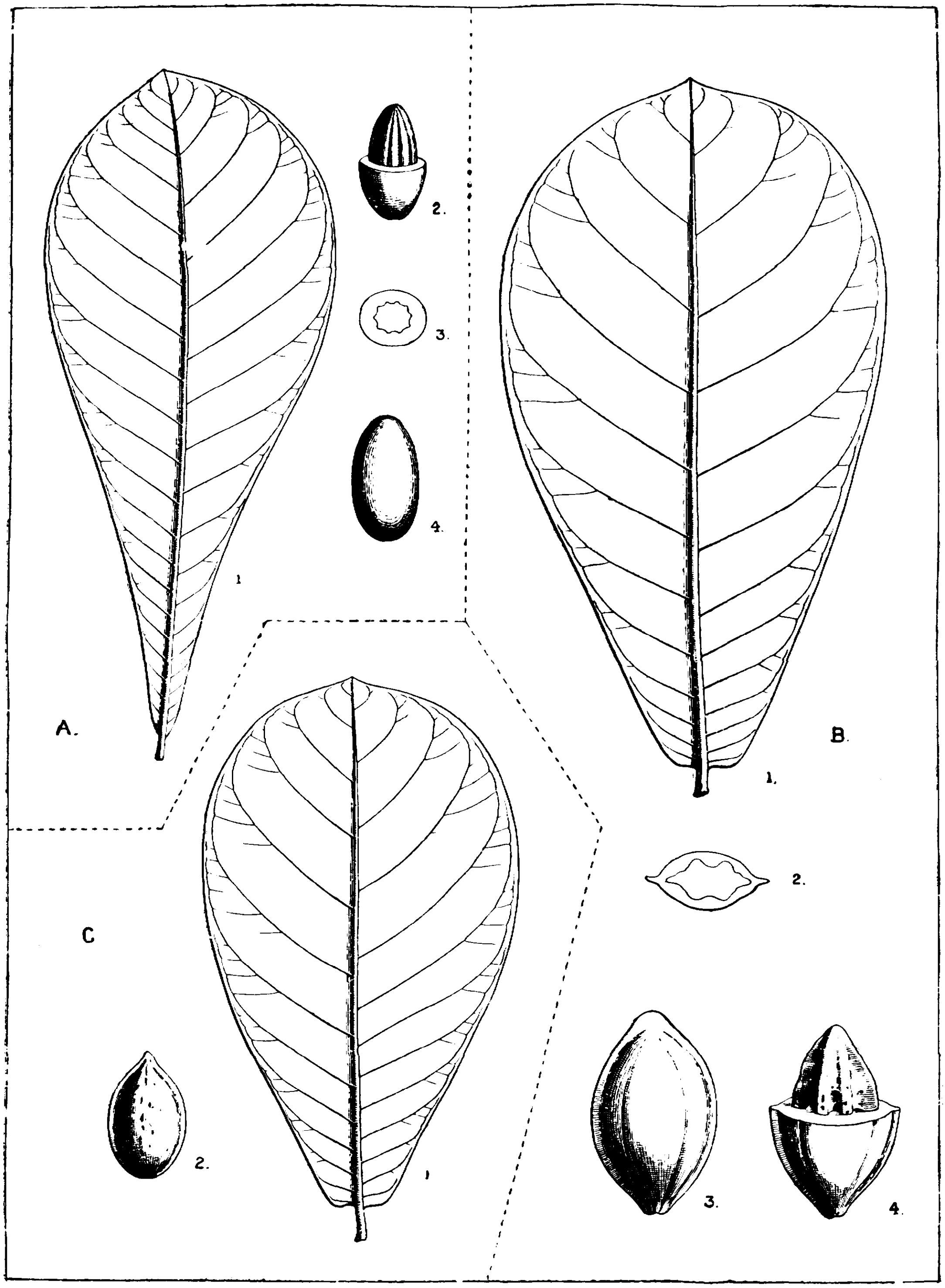
Leaves 8-14 in. long and 5-8 in. broad, obovate, tapering down to the small cordate or auricled base, petiole short and stout. Fruit ellipsoid-compressed with two opposite more or less sharp keels or ridges, $1\frac{1}{2}$-$2\frac{1}{2}$ in. long and almost two-thirds as wide.

Wall. Cat. 3975 C. and E. ; Herb. Wight 1006 ; Herb. Griffith 2180/1, Malacca, Dr. B. Seeman 188, Fiji islands, 1860 ; Cleghorn, South India ; S. Kurz, Ross island, South Andaman, 2-2-1875 ; H. Forbes 1806, Sumatra, 1880 ; King's collector 450, Andamans 1884 ; D. Prain, Ross island, South Andaman, 18-11-1889, also Diamond island, littoral, 21 and 22, Nov. 1889, also Great Cocos island, Dec. 1889, also Narcondam, March 1891, also Barren island, April 1891 ; King's collector, Goplakabang, South Andaman, 16-9-1893, also Anikhet, South Andaman, 9-12-1893 ; C. G. Rogers, Neill island, Andamans, 16-11-1902 ; J. H. Lace 2841, North Button island, Andamans, 5, May 1905 ; A. Meebold 9549, Tarikere, Mysore, October 1908 ; C. B. Robinson 414, Amboina, Sept. 1913 ; C. E. Parkinson 111, Long island, Andamans, 6-6-1913, also 761, Long island, 5-12-1915, also 516, Jolly Boys' island, 28-4-1916, also 1152, Middle Andaman, east coast, 25-3-1916 ; Sukoe 10951, Victoria Point seashore, Burma, 16-3-1930 ; Maung Po Khant 11358, Victoria Point, Mergui district, 21-3-1930 ; C. E. Parkinson 13960, 14407, 14615 and 14951 all collected at Rangoon in 1932.

T. procera Roxb. Cor. Plants III (1819) p. 18, t. 224 and Fl. Indica ii. (1832) p. 249 ; Kurz For. Fl. Brit. Burma i (1877) p. 454 ; C. B. Clarke in Fl. Brit. Ind. ii (1878) 444 ; Parkinson, For. Fl. Andam. Islds. (1923) 167.

T. sp. nov. No. 168, Kurz in Journ. As. Soc. Beng., Vol. 45, 11 (1876) 130.

Leaves 5-10 in. long by 2-4 in. broad, narrowly obovate, tapering downwards into the petiole, base not cordate or auricled. Fruit ellipsoid, not compressed, $1\frac{1}{4}$—$1\frac{1}{2}$ in. long and $\frac{3}{4}$ in. diameter.



Ganga Singh Del. A. TERMINALIA PROCERA ROXB. B. TERMINALIA CATAPPA LINN. C. TERMINALIA BURMANICA KING.

Wall. Cat. 3974; King's collector, Minnie Bay, Andamans, 28-4-1894; R. L. Henig, South Andaman, April 1897; C. E. Parkinson 36, Middle Andaman, 15-3-1913, also 650, Long island, 30-6-1915, also 1150, Middle Andaman, 28-3-1916; H. Bradley, sheet 27535 in Herb. Dehra Dun, 28-3-1916; Fruiting specimens, in spirits in Herb. Dehra Dun, from the Chief Forest Officer, Andamans.

Terminalia burmanica King ex Prain in Journ. As. Soc. Beng., Vol. 73, 5 (1904) 204. This species is based on Abdul Huk's specimens collected at Sagaing, near Mandalay, in August 1891. No specimens of the plant have been collected since then. The height of the tree as given by Abdul Huk on his label, *i.e.*, 200 to 225 feet, is obviously an error. The writer made an endeavour to find this species in Sagaing in 1927, but with no success; he is of the opinion that this species is only the much-cultivated *T. catappa* of degraded dimensions due to the comparatively arid climate of Sagaing where it was grown. The type specimens differ from *T. catappa* only in their smaller size and the absence of glands on the leaves and the grooves seen on the fruits, which are due to shrinkage in drying, are of no specific significance.

Plate 29.—A. *T. procera* showing 1 leaf, 2 fruit cut across to show stone, 3 transverse section of fruit; 4 complete fruit; 1 from C. E. Parkinson's Andaman specimens; 2, 3 and 4 from specimens preserved in spirits. B. *T. catappa* showing 1 leaf, 2 transverse section of fruit, 3 complete fruit, 4 fruit cut across to show grooved stone; all from C. E. Parkinson's Andaman specimens. C. *T. burmanica* 1 leaf, 2 fruit, from Abdul Huk's specimens in the Calcutta herbarium. All half natural size.

VARIATION IN THE PROPERTIES OF DALBERGIA SISSOO (sissoo) FROM DIFFERENT LOCALITIES IN INDIA

By V. D. Limaye,

Forest Research Institute, Dehra Dun.

For the purposes of this investigation specimens of sissoo were obtained for testing from seven different places.

The following table gives details about the localities and general conditions of growth of the seven different samples of timber :—

Dalbergia sissoo (sissoo)

Serial No.	Locality	Position approximately	Altitude in feet	Girth at breast height (inches)	Average height of tree in feet	REMARKS
		Lat.—Long.				
1	Motichur Range, Dehra Dun, U.P.	30°N—78°E	1,500	75	75	Full consignment of 5 trees
2	Kodarma Range, Hazaribagh, B. and O. ..	24°N—85°E	500	61	74	Do.
3	Una Range, Hoshiarpur (Punjab)	31° 30′N—76°E	1,000	93	68	Consignment of 3 trees
4	Daina Range, Jalpaiguri (Bengal) ..	26° 45′N—89°E	300	77	90	Full consignment of 5 trees
5	Changamanga Plantation (Punjab) ..	31°N—74°E	probably below 500	..	..	Small lot of scantlings
6	Hazaribagh ..	24°N—85°E	probably 500 ft.	..	..	Do.
7	Nepal (through Gun Carriage Factory, Jubbulpore) ..	..	probably about 2,000 ft.	..	..	Do.

It will be seen that there is a great variation in the geographical situation and altitude from which the consignments came. No. 5, for instance, came from plantations about as far west as 74° longitude, while consignment No. 4 was obtained from the eastern part of India at about longitude 89°. The altitudes also varied from a more or less plain plateau of 300 feet, to hilly forests of 1,500 to 2,000 feet elevation. The variations in the conditions of growth were also worthy of attention. Consignments Nos. 1, 4 and 7 were from well-stocked forests. No. 3 consisted of road-side trees from Hoshiarpur, while No. 5 was from irrigated plantation in the Punjab.

Strength

From an analysis of the strength figures of all consignments of sissoo so far tested at Dehra Dun, this species can apparently be divided into three broad groups for strength purposes—

I. Sissoo from near the foot-hills of the Himalayas, from high elevations of about 1,500 feet and up and including Dehra Dun, and Nepal.

II. Sissoo from the plains outside the Himalayan belt, from high elevations up to about 1,000 ft., and including especially Jalpaiguri, Hazaribagh and Hoshiarpur.

III. Sissoo from Punjab irrigated plantations.

The first group, as a whole, contains the strongest timber. The strength of Dehra Dun sissoo, given in the following table, represents the average of 5 trees while the figures for Nepal sissoo were obtained from only a few scantlings which might have been from selected material as they came from the Gun Carriage Factory. Sissoo from Dehra Dun, however, gave strength results which were practically equal to those of Nepal sissoo. Although no definite comparison can be established between these two consignments due to the insufficiency of the Nepal sissoo tested, it can be said that Dehra Dun sissoo is at least equal to that from Nepal.

The second group, obtained from the plains at some distance from the Himalayan range, came next in order of strength. This group, as a whole, was roughly 10 per cent. lower in static bending, compression parallel to grain and hardness, and about 20 per cent. lower in impact bending than the first group. There was not much difference of practical importance in the strength of the specific consignments of this group, *viz.*, Jalpaiguri, Hazaribagh and Hoshiarpur road-side consignments, as can be seen from the table, although there were some variations in individual functions. The Jalpaiguri sissoo was found to be much lower in hardness while the Hoshiarpur consignment was a bit weaker than the others in static and impact bending and in compression parallel to grain, and stronger in compression perpendicular to grain and hardness. The shrinkage was also greater for Hoshiarpur sissoo.

In the case of the third group, *viz.*, Punjab plantation sissoo, no definite conclusions regarding strength could be drawn as the specimens tested were very few and defective. Therefore, the strength values have not been given in the table. Although the tests that were made so far indicated that clear selected material from these plantations may come up to the standard of sissoo from the plains, this material has been classed as a group by itself for the present.

The values given in the following strength table are for air-seasoned material and have been reduced to a uniform moisture content of 12 per cent. They are, therefore, directly comparable with each other. The last line in the table expresses the strength of group II as a percentage of that of group I. The strength of teak is also shown for comparison at the top :

Strength of Dalbergia sissoo (sissoo).

Group	Locality	Moisture %	Specific Gravity Oven-dry	Weight at 12% moisture content lbs. per c.ft.	Shrinkage Green to Oven-dry: Radial	Shrinkage Green to Oven-dry: Tangential	Static Bending: Modulus Rupture lbs./sq. inch.	Static Bending: Modulus of Elasticity 1,000 lbs./sq. inch.	Impact Bending: Maximum Height of Drop in inches	Compression Parallel to Grain: Maximum Crushing Strength lbs./sq. inch.	Compression Perpendicular to Grain: Crushing Strength at E. L. lbs./sq. inch.	Hardness: Average of side and end in lbs.
	Burma and Malabar teak (for comparison)	12	·611	43	2·3	4·2	15,035	1,876	24	8,920	1,570	1,145
I	Dehra Dun (U. P.) ..	12	·721	50	2·7	5·5	14,790	1,609	53	8,325	1,945	1,895
	Nepal ..	12	·676	47	..	..	16,185	1,590	47	8,565	1,765	1,560
	Average ..	12	·699	49	2·7	5·5	15,490	1,600	50	8,445	1,855	1,730
II	Jalpaiguri (Bengal) ..	12	·668	47	2·7	5·6	13,845	1,664	42	7,610	1,500	1,315
	Hoshiarpur (Punjab) ..	12	·713	50	3·4	5·5	13,165	1,344	37	7,380	1,760	1,865
	Hazaribagh (B. and O.) ..	12	·671	47	2·8	4·9	13,940	1,539	39	7,505	1,720	1,420
	Average ..	12	·684	48	3·0	5·3	13,650	1,516	39	7,500	1,660	1,535
Group II as percentage of Group I ..		..	..	..	..	..	88	95	78	89	89	89

Working Qualities

The following are extracts from reports on the working qualities of the consignments by the Officer in Charge, Wood Workshop Section :—

Dehra Dun sissoo.—An easy timber to handle. Cuts, turns, machines and peels well without any special machine features having to be adopted. Although the timber is often a little interlocked, it works up easily to a good finish and takes a fine polish.

Hazaribagh sissoo.—Planes and turns satisfactorily under ordinary conditions. Though somewhat interlocked, it is suitable for furniture and turnery. No special adjustments to saws and machines are necessary.

Jalpaiguri sissoo.—The material was straight-grained and it machined and worked up beautifully with very little effort. It was the easiest piece of sissoo that was ever worked in the Wood Workshop. It had a rich dark colour, very suitable for furniture, panelling and veneer work.

Hoshiarpur sissoo.—The material was found to be somewhat refractory to work. It was hard, coarse and not too amenable to machinery. The fibres picked out badly and it contained abnormal quantities of a white deposit which acted as an abrasive to the machine knives. It appeared to be suitable for rough work only.

Changamanga plantation sissoo.—Three varieties were examined. The light coloured, straight-grained timber was easy to work. But the light coloured, cross-grained material was hard to work, both by machine and hand, and dulled the tools due to a granular deposit. The dark coloured sissoo appeared to be midway between the cross-grained and the straight-grained, light coloured variety.

From an examination of the reports on working qualities, it is seen that sissoo from Hoshiarpur and Changamanga was difficult to work and appeared to suffer more from interlocking than sissoo from Dehra Dun, Hazaribagh and Jalpaiguri. From the data available

from this investigation and from other work done with sissoo, it can be said that sissoo from Dehra Dun and the eastern parts of India has been found to be easier to work than that from the more western regions.

Conclusions

The broad general conclusions that can be arrived at from this investigation may be summed up as follows :—

(1) Sissoo from the foot-hills of the Himalayas has been found in general to be superior in strength to sissoo from the plains outside the Himalayan belt.

(2) Sissoo from Dehra Dun and the eastern part of India has so far been found to be easier to work than sissoo from the more western regions.

EFFECT OF FORESTS ON EROSION, FLOODS, CLIMATE AND RAINFALL, AND ON IRRIGATION EXPERIMENTS

A Summary of a Lecture delivered by Mr. W. D. M. Warren, I.F.S., Forest Research Officer, Bihar and Orissa (?) at the Science College, Patna University.

During the course of his lecture, Mr. Warren explained the evil effects of denudation. He said that "the gradual disappearance of forests in several countries of the world to-day is so changing the climate and soil conditions, that the very existence of the people is threatened." He gave an instance of America where the problem had become so acute that "the Government is now spending large sums of money to plant up portions of each farmstead, with the object of giving employment, conserving moisture for the agricultural crops, and providing shelter for the live-stock." He further said that on account of denudation on the Chota Nagpur plateau, which was still proceeding, the climate had changed to such an extent that it was no longer possible to extend plantations of tea there.

While discussing the question of erosion which was, Mr. Warren said, accelerated by annual fires and grazing, he quoted the data collected by the United States Forest Service which showed "that on

HINOO RIVER IN FLOOD, SEPTEMBER 1930. UNPRECEDENTED, DUE TO EXCESSIVE DISFORESTATION ON THE RANCHI PLATEAU *Photo : E. Benskin.*

DENUDATION AND EROSION IN THE SHAHPUR-KANDI AREA, PUNJAB *Photo : V. W. Smith, Indian Police.*

LAST STAGE OF DENUDATION ON HILL SLOPES, RANCHI. BARE ROCK EXPOSED WITH A SOLITARY SURVIVING SAL TREE ON THE TOP. *Photo: W. D. M. Warren.*

GRAZING DAMAGE. NOTE THE ABSENCE OF GRASS OR REGENERATION *Photo: J. R. Sabharwal*

ploughed land where furrows run down-hill, a six inches layer of soil would be washed away in 10 years, in 28 years where contour ploughing is done, in 12 years on barren idle land, but in oak forest only in 40,000 years." He also drew attention to the fact that the Orissa Floods Committee calculated that if 6 per cent. of the flood waters of the Mahanadi in 1911, and 4 per cent. in 1920, had been delayed for each of five days, those floods would probably not have occurred. It would, therefore, be seen that how necessary it was to preserve forests on the hills in order to safeguard the prosperity of those living below.

Mr. Warren also pointed out that the Government of Bihar and Orissa, having been alarmed at the rate of denudation which was going on, had decided to offer to lease suitable and compact areas of forests belonging to private owners for 35 40 years, the Government to pay the cost of management and an annual rent of one to two annas per acre and to share the profits, if any, with the owner. Even though this scheme will involve a loss of about Rs. 40,000 a year the necessity for conserving the forests was so great that the Government was prepared to face this drain on their treasury.

Mr. Warren said that against 15 per cent. of area under forest in a highly industrialized country like Germany, Bihar and Orissa had only 5·5 per cent. which was quite inadequate to meet the requirements of the people.

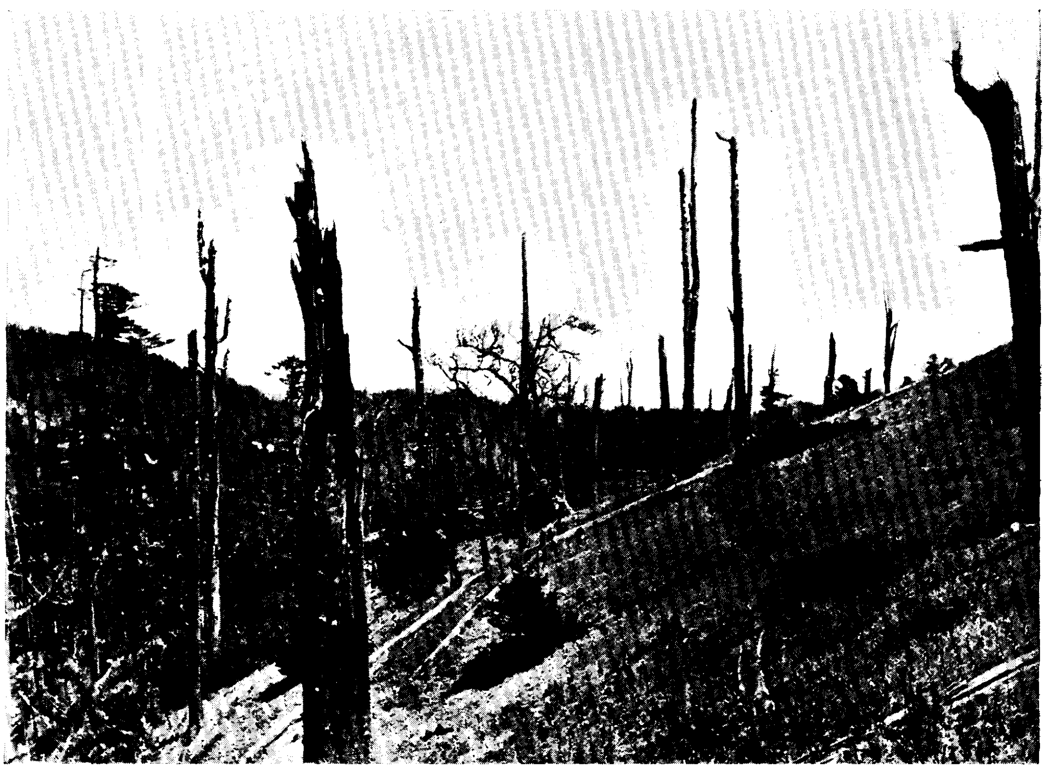
Mr. Warren, towards the end of his lecture, described an interesting irrigation experiment recently initiated by the Government of Bihar and Orissa. " The aim of the Department is to improve the condition of the forests under its control. These improvements are doubly attractive if, in addition to being good financial investments, they fit in with the Orissa Floods Committee's recommendations for lessening flood damage and erosion. Irrigation does this. Level earthwork, contour channels with small masonry bundhs at stream crossings, are constructed on hill-sides to arrest the run off of water diverting it along the face of the hill from where, except for excess water escaping it, it can only get away by percolating down through the soil past the roots of trees. Three and a half miles of channels

have been dug in the last three years, at Bamiaburu, Kolhan Division, and already there is a big improvement in the growth and condition of the forests calculated to give at least a 6 per cent. interest return on any money invested, provided the staff is not increased. Moreover the climate in the irrigated area is changing. The air now is noticeably colder and damper. In November last, in shirt sleeves, at the entrance to the area I involuntarily shivered with cold—a thing I had never done before at that place during my five years in the division, although I had visited it at all times of the year."

Temperature readings taken on the 6th February, between 11 a.m. and 2 p.m., outside the area at the rest-house and at various points inside, showed a maximum difference of 4°F. (79°F. and 75°F.) and a difference in relative humidity of 17 per cent. (52 per cent. and 35 per cent.).

The lowered temperature and greater humidity cause clouds to form and a precipitation of rain under favourable conditions. Daily observations kept over a period of two months and twenty days from mid-November 1935, until January 30th, 1936, show that on 29 days, clouds were visible in the sky. Only on one day did they disappear before reaching the irrigated area. On the remaining 28 they were heavier there than elsewhere and usually remained for two hours longer. On several occasions they were seen only over the area and nowhere else. On Xmas day rain threatened. Slight rain fell on the 8th January and heavier rain fell on the 30th, when the Conservator of Forests was there. To quote his words, "I have been fortunate during my present tour to have been present in the neighbourhood of Bamiaburu while winter rain and clouds have been plentiful. These have been blowing from south-west to north-east quite steadily. On January 30th, 1936, I was surprised to notice that, as I approached Koira which lies roughly north-east (the leeward side) of Bamiaburu and the irrigated area, the road, though level, was fully soaked and had water lying in places. Although it had rained before getting to Koira and after passing it towards Saitba, the dust on these ends of the road was nowhere fully wetted and my car in passing uncovered dry dust practically everywhere. On the section immediately east and

Pinus longifolia FOREST CLOSED TO GRAZING WITH GOOD REGENERATION RESULTING. KANGRA DIVISION, PUNJAB. *Photo : R. S. Troup.*



THE LAST STAGE OF DESTRUCTION OF *Abies densa* FOREST DUE TO BURNING AND GRAZING. ONE OR TWO SAPLINGS EXIST AND SHOULD SURVIVE WITH PROTECTION. HEAVILY BROWSED *Arundinacea* IS VISIBLE IN THE FOREGROUND AND *Betula utilis.* SANDAKPHU, DARJEELING DIVISION, BENGAL. *Photo: H. G. Champion.*

PHOTO MAY 1934, SHOWING DAM AND CONTOUR CHANNEL IN COURSE OF CONSTRUCTION. IT ARRESTS RUNOFF OF WATER, PREVENTS FLOOD AND IMPROVES FOREST CROP.

PHOTO SHOWING DAM AND CONTOUR CHANNEL AFTER 2 YEARS IRRIGATION IN 1935. NOTE THE IMPROVEMENT IN FOREST GROWTH. *Photos : W. D. M. Warren.*

west of Koira, however, over a total distance of about three miles, practically no dust was uncovered, and as I say, water was lying in the wheel tracks. I was not convinced of the reason for this, however, until I returned to Goilkera *via* Bamiaburu and found that although rain had been heavy at Koira about two miles as the crow flies across the ridge, the rain in the irrigated area had only been in the nature of a drizzle. The heavy clouds which formed over Bamiaburu could be seen passing north-east across Koira and the explanation, therefore, appears to be simply that the cloudy air, until it reached Bamiaburu, was not fully saturated to cause precipitation, but on passing over the irrigated area absorbed more moisture and became cooler until saturation point was reached, when precipitation took place, the full effect of which was only felt between one to two miles from the area." Government have approved of continuing the experiment and of spending Rs. 10,000 in the next four years, which should be sufficient to construct thirty miles of channels.

THE BIHAR AND ORISSA FOREST STALL AT THE PATNA PROVINCIAL EXHIBITION, 1936

BY W. D. M. WARREN, I.F.S.

1. The Editor has asked me to write an account of our forest exhibits and how the general public appreciated them.

The Patna Provincial and All-India Weaving Exhibition was held from the 10th February until the 3rd March 1936, during which time well over one lakh of people visited it. It was the first exhibition held on a large scale since 1919, and from all accounts far surpassed the effort made then.

When in June of last year we were invited to participate, few exhibits were available. At a local Patna Exhibition, fifteen months previously, we had sent down Babu K. L. Mullick, E.A.C.F., with a set of hand specimens of Indian timbers. He was assailed on all sides by such questions as, " Where do you come from ? " " Where

are your forests ?" "Tell us all about them," and "Next time you come bring a more comprehensive collection of exhibits." Even M. L. C.'s and University Lecturers asked these questions and this made us, with our Headquarters in Ranchi, feel how little we were in touch with the people of the Gangetic plain. In these days of democratic Government, we can scarcely expect Provincial assemblies to meet our demands, unless we explain to them how necessary forests are for the welfare of the people. When they realise these things they readily appreciate our worth. They quickly grasp the fact that our value to the community is not to be measured by the profits we may make ; but, that even run at a loss, a forest service must still be strongly supported.

Messrs. Sabharwal and Khan had drawn up a comprehensive list, intended for the previous local exhibition, which gave a splendid foundation on which to work. Divisional Forest Officers were also invited to send in lists of exhibits they could make or collect. Later, at the Conservator of Forests' suggestion, medicinal herbs and fruits were also included. As a result, specifics for all known and unknown diseases were collected ! !

2. A visit to the Forest Research Institute, Dehra Dun, in September, convinced me that a collection of specimen 6′ planks of the Province must form the background on which to build our other exhibits. Anyone who has been to the Institute knows how the Economic Museum walls are lined with specimen planks from all over India, and how fine they look. We collected from all sources specimens of thirty different species and very fine they looked too after they had been planed, sandpapered and the top half wax polished. They gave tone to the whole stall. These planks were placed along part of the partition front and along the left hand wall so that they caught the eye immediately on entering the stall. They gained for us a silver medal.

In the centre of the stall which was $40' \times 40'$, different pieces of furniture were grouped around a folding camp table of satinwood. Chairs were placed at each corner, of rosewood, laurel and *piasal* (*Pterocarpus marsupium*) with peg tables between, of the same woods.

At the one side was a *gumhar* table with ebony inlaid with a *gumhar* cupboard on top. This cupboard also gained a silver medal. On the centre, on top of the folding satinwood table, stood a very neat hexagonal ebony waste-paper basket. A rosewood smokers' table and a satinwood occasional table loaned from Dehra Dun completed the furniture.

3. Dehra Dun made for us a copy of their beautiful laurel laminated veneer screen to be seen in the Inspector-General's room. It was admired by all and could have been sold many times over. It served its purpose well, to advertise the beauty of Indian laurel. As a result we feel encouraged to set up seasoning sheds for seasoning this most difficult of Indian timbers, as a demand is being created. This exhibit also gained a silver medal.

Along with the screen, Dehra Dun sent sample squares showing how veneers were built up, squares of three-ply wood and two sample tea chests of *Vateria indica* and *Canarium strictum*. A chart also gave the strengths of Indian timbers compared with teak. Many visitors were interested in this, while several asked for copies. The Institute is printing these out.

An exhibit of picker arms made of *dhaura* (*Anogeissus latifolia*), whose crushing strength was greater than that of hickory, attracted attention. There is a good market for tool handles made of this wood, awaiting a contractor with enough enterprise to set up lathe machines.

4. At the back of the stall and ranged right along its length were continuous three-tiered tables for the display of minor forest products, medicinal herbs and fruits. These included cane and bamboo hats, toys of *bhurkund* (*Hymenodictyon excelsum*), *Holarrhena* and teak wood, cloaks and umbrellas of *Bauhinia* leaves sewn together and used by the aborigine tribes, and even a kilt from Bastar State of long dried grass leaves caught at the top to form a belt. Ladies were very intrigued with this, as also with the cane and bamboo topee hats. Paper pulp exhibits of the Indian paper pulp showing stages in the process of manufacture also gained a silver medal. Biri, cutch and lac exhibits each received a certificate of merit, and another certificate went to wooden sandles of *gumhar* inlaid with rosewood,

Four charts from the Eastern States Agency Forest School showing animal, vegetable and mineral products of the forests, neatly fixed and labelled, formed a very nice centre piece. Matchwood veneers and finished products formed another exhibit, while exhibits showing damage done to *sal* and bamboos from the Forest Entomologist added a scientific touch.

Along the right hand wall, *sal* B. G., M. G., N. G., and tramline sleepers reminded visitors that these formed the bulk of our exports, and a dinky half-sized cart such as kiddies would love to play with from Angul, showed how the bulk of our forest produce is extracted.

Near the exit were two tables, one showing what fire-proofed, varnished and Ascu-treated wood looked like, and the other showing the "Grave Yard tests" for the Ascu preservative. Out of six untreated *sal* 3″ thick stakes put down last rains in Ranchi, only two had survived and these were very badly attacked. *Asan* stakes slightly bigger were also badly attacked, whereas treated stakes of both species had not been touched. An exhibit of a treated bamboo which had survived three years' attack at Dehra Dun, attracted much attention. Local *mistries* would scarcely believe it possible for bamboos to last so long. The untreated specimens had been destroyed in eight months. We sent off hurriedly to Dehra Dun for pamphlets in Hindi explaining this new Preservative treatment, but none were available. A poster on the need for preserving wood explained matters very well to the layman.

Another poster from Dehra Dun showed a photograph of planks properly stacked with air spaces for seasoning and the advice given was very instructive. Still another one consisted of a series of photographs showing the various tests for strengths to which woods were subjected at Dehra Dun.

Seeing all these posters on seasoning, preservation and strengths of timbers, the Deputy Director of Industries exclaimed: "You know, I consider your stall the most important one in the whole exhibition, because so few people know anything about woods and how to handle them." He also said that the posters should be written in Hindi as well as in English. Another critic said that the

names on our specimen planks should also be in Hindi as well as in English and Latin.

The "Save your Forests" posters from the Forest Research Institute were displayed prominently at the entrance to the exhibition. A 10′ poster showed that Bihar and Orissa, with only 5 per cent. of its land under forests, was second lowest on the list of the Indian Provinces, whereas Burma had 60 per cent. It was pointed out that each Province to be self-supporting should have 16 per cent. under forests. Before I complete my description of the stall, I must not forget the six framed and painted photo enlargements, 23″×17″, of systems of forest management which the Silviculturist sent. One was of teak *taungya*, another a seeding felling in *chir* pine, two more *sal* and teak pole crop. They transported the visitor in imagination to the beautiful surroundings in which our forests grow.

The Value of Exhibitions.—Perhaps the chief value of exhibitions is the opportunities it gives Forest Officers to come into direct contact with the people. By this means we find out their needs and their difficulties and can educate them to utilise wood to the best advantage. It is surprising how ignorant most people are of the value and properties of the different species. Even such educational institutes as the Bihar Engineering College at Patna, had no collection of hand specimens of Indian timbers, nor a copy of Limaye's book on their strengths. The only woods Engineers in this Province seem to know are *sal* and teak. They know nothing about the seasoning of timbers and yet everywhere the cry is for seasoned wood. One Engineer solemnly informed me that once he carefully seasoned wood in the plank form with proper spaces between each and yet the planks all warped, and for a long time I could not find the solution to that problem, namely, that the foundations of pile could not have been level.

We want more and more posters for distributing to the Trade. At present most of the valuable information which the Research Institute has found out for us is in books which never reach the general public and are not always read by Forest Officers, whereas

posters on the lines of those sent to the Exhibition bring the salient facts to the notice of all. Not only is it important to discover things, but it is equally as important to make those discoveries widely known to all those who stand to benefit. Copies of such posters should find a place at every timber depot.

It is also necessary to inform the people of the indirect value of forests for the amelioration of climate, and mitigation of erosion and flood damage. Many people appear to think that our interests clash with those of agriculture, whereas the truth is that the two go hand-in-hand, that good agriculture depends upon the proper distribution of rainfall, with timely showers in the dry weather months, which forests alone can ensure. Even we foresters think that we must not only pay our way, but make profits for the State, forgetting that economic value is only one of the many benefits which forests can bestow.

Our policy in the past reminds me of the ostrich which buries its head in the sand, becoming oblivious to its surroundings. We have been so immersed in our silvicultural and extraction problems, that we have remained in complete ignorance of what happens to the wood afterwards, or what sort of wood the community requires. Exhibitions will give us that knowledge.

If exhibition stalls are to be run properly, they must be adequately staffed. I had two Extra Assistant Conservators, my Utilisation Ranger, two Foresters and three Forest Guards, and there were times in the day during rush hours when all of them were busy explaining the various exhibits to visitors. We made a point of doing this with every one really interested, so that quite a considerable number of the lakh or so of people who visited the exhibition now know something about the Forest Service of this Province.

A FOREST FIRE CAUSED BY FALLING STONES

By G. R. Henniker-Gotley, I. F. S.

Felling work was in progress in 1/2 Reoni Cpt. V, a *chir* forest situated in the Parbatti valley of the Kulu Forest Division. Reoni

is a steep forest, very often precipitous in places, and felling of trees on such ground is no easy matter. At this time of year, the grass and undergrowth is like tinder, the winter rains have not commenced, and frost and the cold winds have dried everything up. Only those trees are marked which it is considered can be felled without being smashed to pieces. Even so, accidents will happen. At 4 p.m. on the afternoon of December 21st, a big tree was felled, and in spite of being held by wire ropes to direct its fall and stop it rolling, it got out of control and slipped down the steep hill-side, dislodging several large rocks.

These rocks (quartzite) rolled down and striking against other rocks, caused sparks to fly, which ignited the dry grass. The fire spread rapidly up the steep slope until the whole forest was ablaze.

Actually very little damage was done, as the fire was purely a ground fire, and did no more than scorch the bark of the trees which were already felled.

Two other instances are recalled where fires have been caused by similar circumstances: (1) In Agdhar *chir* forest, near Taklech, Lower Bashahr Division, about 1917, when departmental work was in progress, subordinates reported that a fire was started by falling stones. (2) In 1921 in *chir* forests opposite Jehri, seen by Mr. Grieve, Chief Conservator of Forests. These three cases go to prove that fires can be started in this fashion, and this should be considered when investigating the causes of fire which occurs while felling work is in progress on precipitous ground.

Since writing the above a similar case of fire caused by falling stones dislodged when felling *chir* trees in the Nogli valley has been reported. Here, too, the rock is quartzite.

[NOTE.—I can confirm the above statement about quartzite rock. The explanation that the cause of the fire was due to falling stones is, however, not one to which encouragement should be given, or every forest subordinate will take full advantage of such an easy way out of difficulty.—C. G. TREVOR.]

RESULT OF BLUE PINE LOPPING IN BALSON STATE, SIMLA HILLS

BY PRITAM DASS,

Forest Officer, Balson State, Simla Hills

Lopping of trees of any species, unless done for a definite silvicultural reason, is harmful to the growth of such trees and in the disturbance of the canopy as well. But lopping of the kail or blue pine (*Pinus excelsa*) is still more dangerous, as the lopped blue pine tree is seriously attacked by fungus and rendered useless for timber purposes.

In the Simla Hill States, lopping of all the species growing in these tracts was allowed before 1898, when the Simla Conservancy rules were framed by the Punjab Government. Under those rules forests were demarcated for regular exploitation and areas were also left undemarcated near the villages for the requirements of the local inhabitants. The conservancy rules prohibited all the harmful practices in the demarcated forests but said nothing about the management of the *dehati* forests. In compliance with those rules, lopping of all conifers was strictly prohibited in the demarcated forests, but village (*dehati*) forests were kept open for this practice. Deodar being the most valuable species of these forests was exempted from lopping in the village (*dehati*) forests too.

Kail lopping is done by the local villagers for manure and has remained in Balson the rule rather than the exception till recently. Owing to the excessive and wholesale lopping of kail in the village (*dehati*) forests fungus disease spread seriously and did not leave even a single tree of that species unaffected. Destruction of the blue pine in the *dehati* forests attracted my attention. The sole remedy to stop the disease seemed to be by completely prohibiting the lopping of blue pine, but this could not be done unless some substitute for manure was found. At the same time this privilege had been enjoyed by the local cultivators since time immemorial. I had, therefore, to explore all means to stop this formidable practice which seemed to be reducing the *dehati* forests to nil, so that the burden of the local villagers' rights was bound to fall on the demarcated forests and thus affect the revenue of these forests.

While engaged in remedying the evil of lopping I found that deodar regeneration is profusely coming up in all the blue pine lopped areas of the *dehati* forests. This, however, was not the case with the deodar, or mixed kail and deodar, areas. The regeneration in these *dehati* forests has reached the sapling and pole stages, and I can assure the readers that in a few years' time every blue pine area, freely lopped by the zamindars, will probably become pure deodar forest. Speaking on the basis of my personal experience this conversion of the blue pine areas into pure deodar forests should be due to the following factors created by lopping and grazing. Firstly, the blue pine being cent per cent diseased did not produce healthy seeds while the deodar seeds got a free chance to germinate and grow under the partial shade of the lopped blue pine. Secondly, reaching the seedling stage deodar plants got side shade from lopped kail and there was no suppression in the sapling stage, both favourable factors for deodar. Thirdly, these *dehati* areas being just close to the villages are heavily grazed by the cattle from May to October and no bush is allowed to escape the devastating effect of browsing. The grounds, however, get rest more or less for six months in the year, from November to April, when the cattle are either taken down to the valleys where there is no forest, or in case of snow-fall kept in the villages. There is a limited number of buffaloes owned by the state inhabitants who have grazing in the blue pine and deodar forests irrespective of whether the forest is *dehati* or demarcated.

Concluding this note I should like to remark that kail lopping of the type mentioned above, although inimical to its own growth, if helped by periodical cattle grazing and by keeping out the browsers, specially in dry seasons, affords an excellent chance for deodar to invade the area and oust the kail completely.

NOTE BY THE INSPECTOR-GENERAL OF FORESTS.

There is no evidence in support of the statement that the lopping of blue pine is necessary to the agriculture of the Punjab Himalaya. This barbarous practice is common throughout the Simla Hill States and the Seraj tehsil of Kulu. It is unknown in Jaunsar Bawar, Kumaon, or in Kulu proper. In Seraj many villages have no pine

trees to lop, and their agriculture is in no way inferior to that of villages in the neighbourhood of the forest who can obtain these loppings. As a bedding for cattle, many other substances, such as fern, are available and are probably superior. It is my considered opinion that the lopping of pine for manure is entirely unnecessary for agriculture and the sooner it is prohibited the better. Wherever this lopping is carried out the pine trees are infested with *Trametes pini* and in consequence are worthless. Where pines are not lopped this disease is absent. The fructifications of the fungus invariably appear on the site of a lopped branch, so that it has been proved that lopping is the sole cause of the disease.

As regards the reproduction of deodar under lopped blue pine this is also well known and is due to the canopy of the blue pine providing ideal conditions of light and shade suitable for the deodar, but probably too dark for the reproduction of the blue pine. In any case, these ruined forests are being replaced by deodar and nature has revenged herself for the atrocities committed by the local inhabitants who will, in a few years, find that they have no pine trees to lop.

INTERNATIONAL CONFERENCE ON TIMBER UTILIZATION, LONDON

The Second International Conference on Timber Utilization convened for the 31st March 1936, terminated its work on 3rd April.

The Conference was arranged by the Comité International du Bois', Department for Timber Utilization in conjunction with its member organization, the Timber Development Association, Limited.

Approximately 100 delegates from 21 countries attended, and the importance attached to the conference in English circles may be gauged from the fact that on the occasion of the opening ceremony, the Chairman, the Earl of Dunmore, was in a position to read a telegram of welcome from H. M. the King of England. This is the first time that an English monarch has honoured a conference of delegates from any branch of commerce with a personal message.

In the course of his speech of inauguration Lord Dunmore referred to the importance of timber as a raw material in the whole economic structure of the world's trade, and stated that it was estimated that there were nearly 400 million pounds sterling invested in the timber trade.

Krystyn Count Ostrowski, President of the C. I. B., mentioned in the course of a lengthy report, that timber was now fourth on the list of materials figuring in international trade.

During the three public sessions, papers on the following points were read, *viz.* :

" Forestry and Timber Utilization "

Sir Roy Robinson (Chairman of the Forestry Commission): " Forestry and Timber Utilization in the British Empire and Great Britain."

Mr. J. N. Oliphant (Director of the Imperial Forestry Institute, Oxford University) : " Forestry and Timber Utilization in the British Colonies."

Mr. K. G. Fensom (Timber Commissioner for Eastern Canada): " Forestry and Wood Utilization in Canada and the United States of America."

Sir Alex. Rodger : " The Marketing of Timbers and its Effect on Silviculture in India."

Docent Erik Lundh (Director, Swedish Forestry Association, Stockholm) : " Forestry and Wood Utilization Problems in Sweden."

Professor Martti Levon (Director, Finnish Wood Research Association) : " Forestry and Wood Utilization in Finland."

" Timber Research and Timber Utilization "

Major Brauer (Manager of the " Arbeitsgemeinschaft Holz," Berlin) : " The Fundamental Ideas of the Propagation of Timber in Germany."

Mr. E. H. B. Boulton, M.C., M.A. (Technical Director, Timber Development Association, Limited, London) : " Educational Problems related with Timber Utilization."

Dr. Von Monroy (Chairman of the "Ausschuss für Technik in der Forstwirtschaft," Berlin): "Modern Forestry and Timber Problems and their international, social, economic and political importance."

Mr. H. Tomsche (Manager of Austrian Federal Forests, Vienna): "The Problem of Quality in Timber Utilization."

"The Utilization of Wood Waste"

Mr. Charles Colomb (Inspecteur Général des Eaux et Forêts, Paris): "Wood gas Problems."

Professor Dr. F. Bergius (Heidelberg): "Wood a new raw material in modern Chemistry."

Professor E. Hägglund (Technical High-School, Stockholm): "New Problems of Chemical Wood Utilization in Sweden."

Professor Dr. Serafino de Capitani di Vimercate (President, Comité International du Carbone Carburant, Milan): "Wood and Charcoal gas."

The international collaboration in all matters concerning the wider utilization of timber has already shown very satisfactory results. Within the past year the number of national organizations which had pooled their efforts to propagate the use of timber has been trebled.

At the conference the various papers showed the similarity of the problems with which timber is confronted in the various countries.

Another very important result of the conference has been the conviction, firmly established, that timber will, in a very short time, become one of the most important raw materials, ranking next to iron and coal.

The research work carried on for years has to-day reached a point where the making of foodstuffs, of textiles, and of fuel for cars from wood has become a sound commercial proposition. The uses to which wood can be put are so varied and of such importance to national economics that further developments on these lines may be expected in the very near future.

A main committee was appointed to receive the reports on the activities of the various national organizations for timber utilization, and sub-committees dealt with measures to be adopted for future work.

The conference may be accounted a complete success, if only from the fact that 21 countries were represented on this occasion compared with but 11 at the last. Moreover the necessity of international collaboration and the success of the work hitherto carried out by the C. I. B.'s Department for Timber Utilization was unanimously recognized by the delegates.

As a consequence, technical and research problems connected with timber will be dealt with in a manner commensurate to its importance from a national and international point of view.

In addition to decisions respecting technical details to ensure effective extension of the work of the Department, it was resolved in principle—

(1) To continue and intensify international collaboration ;

(2) To arrange international inquiries ;

(3) To organize international competitions.

Lastly, it was considered whether all the countries now represented at the conference should participate in a pavilion at the World Exhibition to be held at Paris in 1937.

To afford the delegates an opportunity of seeing examples of modern timber utilization in interior decoration, the sessions were held both at the London Chamber of Commerce and at the new headquarters of the Royal Institute of British Architects.

On the second day of the conference, the delegates had an opportunity of visiting the Princes Risborough Forest Products Research Laboratory, the imporant and well-equipped centre of English timber research. There they enjoyed the hospitality of the Director, and part of the discussions of the main committee took place in the Board-room there.

On the evening of the first day, a banquet was given by the T. D. A. in honour of the delegates attending the conference, and diplomatic representatives of various countries as well as leading figures in English political and business life, honoured the affair with their presence in the historic rooms of the Hall of the Worshipful Company of Carpenters.

In accordance with a decision of the conference, the C. I. B.'s Department for Timber Utilization will be printing a detailed report in English, French and German, with the full text of the lectures held.—*Press Communiqué.*

REVIEWS

ADMINISTRATION REPORT OF THE FOREST DEPARTMENT OF MADRAS PRESIDENCY, 1934-35

The total area of Government forest now covered by sanctioned working plans amounted to 11,793 square miles by the close of the year; plans under preparation or awaiting sanction covered a further 3,622 square miles, and this leaves only 984 square miles (excluding ryots' forests) yet to be dealt with out of the whole area controlled by the Department. The Working Plans Circle is thus nearing the end of the first stage in a notable phase of achievement, most of which has been accomplished in the past seven years.

With the exception of sandalwood, there has been a small but significant increase in revenue under most items of produce. The surplus of revenue over expenditure for the year was Rs. 3·43 lakhs, there being an increase of Rs. 2·83 lakhs in income with a decrease of Rs. 0·37 lakhs in expenditure compared with the preceding year. The report mentions the rapid replacement of timber in building construction by reinforced concrete. Despite this fact, sales of timber removed by Government agency have increased by Rs. 3·56 lakhs—indicative, it is to be hoped, of slow recovery in general prosperity. It is satisfactory to note that the Department was successful in concluding a three-year contract for the supply of sleepers at fixed prices with the Sleeper Pool, Southern Group, notwithstanding tenders by private contractors. Another pleasing feature is the increased demand made by other public departments such as the Jail and Public Works Departments for Madras timbers, in consequence of arrangements whereby the Forest Utilization Officer is consulted before orders are placed elsewhere. A hopeful start has also been made in the departmental manufacture of shellac and wood polish which were sold to jails, industrial schools and commercial firms at good rates. A satisfactory grade of sealing wax has also been produced by the Research Branch working in North Salem District, which is fetching a good market.

There is little of fresh interest to record in the regeneration and general improvement of the forests. Artificial regeneration is relied upon for the most part among timber crops of the more valuable species and progress was generally satisfactory, despite a deficiency of rainfall from both monsoons. Regeneration in the evergreen rain forests still presents many unsolved problems for research. The carrying of vigorous measures of artificial regeneration into the drier fuel districts has imparted to subordinates in these wide areas a marked stimulus and encouragement to "show results" worth looking at, which is by no means a negligible factor of administration. The officers in charge of sandal spike investigation have succeeded in transmitting the disease to healthy sandal by "mass infection" through the agency of insects under control conditions, although

the specific carriers have still to be isolated by further experiment. Practical control methods already reduce the danger of infection to new areas.

The Madras Forest College continued to train rangers for Bombay and Madras Presidencies, and for the Native States of Central and Southern India. The net cost of the College was Rs. 62,435, being Rs. 12,175 less than in the preceding year. Two vernacular Training Schools were also held.

H. P. D.

REPORT ON FOREST ADMINISTRATION IN THE UTILIZATION CIRCLE, BURMA, 1934-35

As far as the financial results of the Utilization Circle in Burma were concerned, there was a distinct improvement for the year 1934-35, as compared to the two previous years. The revenue rose to Rs. 16,82,792 as against Rs. 11,11,361 for the previous year, and the surplus after deduction of expenditure was Rs. 10,89,754 as against Rs. 3,34,078 for 1933-34. The increase was due to an improved market and to a reduction in expenditure. It is regrettable that part of the reduction in expenditure was made at the expense of research, but one's coat has to be cut according to one's purse. The chief experimental activities were a continued study of the beehole borer of teak, the compilation of teak grading rules, the collection of statistics on timber exports and imports, and the preparation of notes and statistics on Burma woods for internal and foreign trade.

Special attention was paid to teak as being Burma's *pièce de resistance* in the timber trade. Formerly it was considered that a well-known timber like teak required no help, but it was realised when the slump came that if teak was to maintain its place in the timber market, considerable research and propaganda would be necessary. Steps were therefore taken to give effect to this policy, and these appear to be bearing fruit already and will no doubt continue to do so. In these days of substitutes every effort possible is necessary to keep timber in the lime-light. Backed with scientific facts and figures

timber can make a very fine showing against substitutes, and in numerous markets, such as, for example, in treated telephone, telegraph, and electrical service and transmission poles, light bridges, cheap containers, and furniture, the substitute which can compete with wood on equal terms does not yet exist. It is not sufficient, however, to think that wood will sell itself. Propaganda and then more propaganda is necessary, and it is a matter of great satisfaction to know that Burma has realised this, and there is not the least doubt that she will feel the benefit as time goes on.

The report under review contains, as usual, a considerable amount of useful and interesting matter, but there is also an appreciable amount of what appears to be most unimportant and almost irrelevant information for an administration report of this type. For example, the chapter on Communications and Buildings could well be contracted to less than 15 pages of what is, at present, rather dull and uninteresting reading. The report concludes with an Appendix comprising the report of the Forest Economist which is full of interesting matter and well worth the perusal of anyone interested in timber research and utilization.

In conclusion, the Burma Forest Department must be congratulated for attaining such promising results in 1934-35, and it is hoped that this progress from the slough of despond will continue; but we *would* like to know why the export of four kangaroos from Burma is mentioned in a Forest Utilization Report!

A GENERAL INTRODUCTION TO FORESTRY IN THE UNITED STATES

By Nelson Courtlandt Brown,

Professor of Forest Utilization, New York State College of Forestry, Syracuse University.

J. Wiley & Sons, 1935. 16 *shillings*.

American foresters are producing numerous volumes on forestry and kindred subjects, which bid fair to provide the American student with a literature which will render him independent of foreign sources. The first American foresters received their training in Germany, and

German theory and practice had a profound influence on the early development of Forestry as practised in the United States. American foresters have been fortunate in the interest taken in their problems by two Presidents, Theodore and Franklin Roosevelt, the first a great administrator who was determined to conserve natural resources, and the second a man who realised that unless practical assistance is given in preservation and reclamation, the magnificent property which the United States possesses in its forests will no longer prove to be a fit heritage for succeeding generations. It is fitting that the latter was the first American to receive the Schlich medal for meritorious services to forestry, and this very succinct summary of American forestry conditions and problems is aptly dedicated to him.

Contemporary with Franklin Roosevelt's government enactments a new appreciation and understanding of the value of their resources is evident amongst American citizens. The widespread activities of the Civilian Conservation Corps as a means of providing employment for town youths in various works of forest conservation and land improvement, has brought home even to the city dwellers the vast amount of work still to be done. The new federal Soil Conservation Service and the Tennessee Valley Authority have concentrated demonstration work in certain areas which are suffering now from the thoughtless exploitation which, up till now, has been an unpleasant feature of American land development. There was always some new "frontier" for pioneers to go on to after the earlier areas had been robbed of their natural riches, but now that the whole country is more or less fully populated, the only remaining "frontier" is each man's own share of the soil which he must learn to protect and conserve if he is not to starve. The soil conservation service now has 41 million acres under some form of erosion control, and the Tennessee Valley Authority is reorganising the whole social life of the primitive mountaineers in the Tennessee and Kentucky highlands stretching into parts of seven different states. Under these circumstances it is not surprising to find that the forestry faculties in the various universities have increased their enrolments by leaps and bounds during the last two years.

The total forest area is nearly 500 million acres, of which about two-fifths contains merchantable timber. Private individuals and companies own 79 per cent. of the area, the Federal Government 18 per cent., and States, Counties and Municipalities 3 per cent. with a tendency to increase. The large majority of virgin forests is situated in the west; in the east the woods largely consist of crops which have regenerated naturally since the original forests were felled. The book gives a short and well illustrated account of these matters and a separate short chapter on each of the phases of government activity which aim at rural reconstruction. The better utilization of the land as a whole certainly serves to bring forestry into prominence, but the forester has to take this place, not as an isolated worker, but as one of a team of specialists all working for the common good.

H.M.G. AND R.M.G.

BURMA TEAK

Burma Teak—the Ideal Timber—is a most fascinating brochure issued by the five large teak firms in Burma who hold long leases from the Government of Burma. Although consisting of only 28 pages, this booklet contains no less than 52 extremely good photographs illustrating the life of teak from the standing tree in the forest to its final destination as a finished product. The illustrations themselves tell the whole story in picture form. They start with the teak tree being felled, and then pass on to the varying forms of extracting teak logs from the Burma forests. The photographs of elephants working in the forest are as good as will be seen anywhere. The same may be said of the pictures illustrating the uses of teak. They range from ancient sailing ships to the modern *Queen Mary*, and from railway coaches to garden seats. Interspersed between the pictures is a running commentary on the illustrations, which by itself would be an interesting story, and as an example of good advertising and propaganda this brochure would be hard to beat. It can be obtained from the Conservator of Forests, Utilization Circle, Burma, Rangoon.

EXTRACTS

WOODWORKING IN ANCIENT EGYPT

In the woodworking trades, as in most others, there is always interest in switching back from the intensely modern machinery and appliances that inventive genius and the skill of the engineers have given us to glance and marvel at the wonderful ability of woodworkers of bygone days with resources that were almost negligible. As most readers know, the art of woodcarving and the crafts of the carpenter and joiner are of very ancient date in Egypt.

Mr. A. Lucas, O.B.E., F.I.C., F.S.A., writes in a most informative way on this subject in *Empire Forestry Journal*. By the Old Kingdom (about 2980 B.C. to 2475 B.C.) these craftsmen had reached a high degree of skill, as is shown, for instance, by (*a*) the six-ply wooden coffin from Saqqâra ; (*b*) the carved wooden panels from Saqqâra ; (*c*) the furniture from the tomb of Queen Hetepheros, the mother of Cheops, who built the great pyramid near Cairo ; (*d*) the carved wooden door from Saqqâra ; (*e*) the wooden statue known as " The Sheikh-el-Belad ; " and (*f*) the ships and shipbuilding depicted on the walls of tombs of this period.

During this time the only metal available for tools was copper, observes Mr. Lucas. From the Middle Kingdom (about 2160 B.C. to 1788 B.C.) examples of woodwork that may be mentioned are (*a*) the immense sarcophagus, the coffin and the canopic box of Amenemhêt, all made of cedar ; (*b*) the ebony and ivory inlaid caskets from Lahûn ; and (*c*) the wooden statue of King Hôr. During this period bronze as well as copper tools were used.

From the Eighteenth Dynasty (about 1580 B.C. to 1350 B.C.) there are (*a*) the furniture and funerary equipment from the tomb of Yuya and Thuyu ; and (*b*) the furniture and funerary equipment from the tomb of Tutankhamûn. Copper and bronze were still the only metals employed for tools, iron not having been used in Egypt for this purpose until about 700 B.C.

Mr. Lucas describes some of the objects. The great antiquity of the plywood coffin may perhaps be better realised, he says, when it is explained that it dates from nearly 3,000 years before the Roman conquest of Britain, which means that it was made about 3,000 years before the history of England began. The coffin, or rather all that remained of it, was discovered last winter in an alabaster sarcophagus in the step pyramid at Saqqâra.

Both the sides and bottom of the coffin consisted of six-ply wood, each layer being about 4 m/m. (0·16 in.) thick and from 4 c/m. to 30 c/m. (1·58 in. to 11·82 in.) wide. The layers of wood were arranged alternately in different directions. Thus at the sides, the innermost layer was vertical, as were also the third and fifth layers counting from inside, whereas the second, fourth and sixth (outermost) layers were horizontal. At the bottom, the layers were arranged alternately crosswise and lengthwise, the uppermost layer being crosswise. At the lower corners, where the sides met the bottom, each layer of wood, except the outermost, was bevelled at the join, and the inside of each of the four corners was strengthened with wooden bars. The different pieces of wood forming the same layer were fastened together

by means of mortise and tenon joints, the tenons, which were separate and loose, being held in position with wooden pegs.

The different layers of wood were also pegged together.

Specimens of the wood were submitted by the writer to Dr. L. Chalk, of the Imperial Forestry Institute, Oxford, who identified them as cypress, juniper and pine, respectively. No evidence of glue was found on the wood.

With regard to the tomb of Hetepheros, when this tomb, which dates from about 5,000 years ago, was discovered, the wood had almost entirely disappeared, probably either as the result of dry rot or from the action of white ants, but sufficient evidence remained to show that there had been an arm-chair, a carrying chair with poles, a canopy, a bedstead and several boxes, most of which had been wholly or partly covered with gold, in some instances with thick gold sheeting and in others with thin gold leaf, though this latter was not nearly so thin as modern gold leaf. In a few cases where small portions of the wood remained, it had shrunk to one-sixth of its original volume.

The excellent craftsmanship of some of the wooden objects from the tomb of Tutankhamûn, which dates from about 1350 B.C., needs to be seen to be fully appreciated. The most outstanding of these objects from the point of view of the carpenter and joiner are (*a*) the four large "shrines" that, nested one inside the other, covered the sarcophagus; (*b*) the chariots; and (*c*) the chairs, stools and boxes.

The shrines are large, oblong, roofed wooden structures with a double door at one end, and are covered, both inside and outside, with a thin coating of plaster (made of whiting and glue), which is decorated with funerary scenes and inscriptions and then thickly gilt, exceptions being the roofs of the two larger shrines, which are mostly covered with black varnish, and the outside of the largest shrine, which, in addition to gold, is ornamented with blue faience. The largest (outermost) of these shrines is approximately 16½ft. long, 11ft. wide and 9ft. high.

The doors are pivoted in sockets, the pivots being conical continuations at the top and bottom of the outer edge of the door, and the sockets being recesses in the framework. Metal hinges, however, very similar to modern hinges, are used on three objects from this tomb, namely, on a large wooden box, on a folding camp bed-stead, and on a small ivory box, the metal in the first two instances being either copper or bronze and in the third case gold.

The shrine doors are provided with two ebony bolts, one at the top and one at the bottom, fitting into metal staples (copper covered with silver). Each shrine consists of a number of sections, which had been assembled in the tomb, and which had to be taken apart to remove them from the tomb, the larger sections or panels being made of separate planks fastened together with wooden pegs, the sections being joined by means of tongues and grooves, the tongues being mostly of wood, some cedar and other sidder (*Zizyphus spina Christi*), with a comparatively small number of copper.—(*Timber Trades Journal and Saw Mill Advertiser*, February 1935).

*INDIAN TIMBERS

Extract Chapter IV of the Report on the work of the Indian Trade Commissioner, London, 1934-35 :—

There was a marked increase in the quantity of hardwoods imported into the United Kingdom during 1934. Indian timbers other than teak did not, however, bulk largely in this increase. Heavy competition continues to keep prices low and freight charges handicap Indian timbers. Teak continues in demand for ship and railway use, but in all forms of construction there is heavy competition from substitutes. The increased use of veneers limits the demand for decorative woods.

In terms of thousands of loads (generally a load is 50 cubic feet, but in the case of softwoods and pitprops imported in the round it is 40 cubic feet) the quantity of unmanufactured timber imported into the United Kingdom from all sources of supply during 1934 compares as follows with the imports of 1933 and the average imports of the five-year period 1926—30 :—

In (000) loads.

	Average of 5 years 1926—30	1933	1934	Change in 1934 on average of 1926—30 + or —
Hardwoods ..	731	587	740	+9
Softwoods ..	5,477	5,930	6,698	+1,221
Not definitely classed as hardwoods or softwoods ..	3,567	3,053	3,657	+90
Total ..	9,775	9,570	11,095	+1,320

In addition to timber, 10 million cubic feet of plywood were imported in 1934 as against eight million cubic feet imported in 1933.

The above figures illustrate the large quantities of timber required for use in the United Kingdom in spite of the competition of substitutes.

Imports of Indian timbers totalled 30,500 cubic tons in 1934, as against 17,300 cubic tons in 1933 and an average of 37,000 cubic tons for the five-year period 1926—30. The main timber imported was teak, but there was some increase in the imports of other timbers, notably gurjan and pyinkado, the latter in the form of flooring strips.

Deliveries of Indian timbers through the agency of this office totalled 1,005 tons in 1934-35, as against 1,210 tons in 1933-34. The decrease is due to shipments not arriving until just after the close of the year. Sales were effected for 1,308 tons in 1934-35 as against 1,190 tons in 1933-34.

ENQUIRIES

Commercial enquiries of the year analyse as follows :—

Enquiries resulting in sales	19
Enquiries for specified quantities of timber, not resulting in sales	15
Tentative enquiries regarding supplies and production ..	11
Indefinite	1
Total ..	46

* Written by Sir H. W. A. Watson, Kt., Timber Adviser to the High Commissioner for India.

In addition there were the usual enquiries from consumers regarding sources of supply of timbers, etc. Amongst these latter enquiries several were for haldu and one for flooring strips of Burma padauk, neither of which appear to be stocked by the London merchants.

The chief decorative timbers in demand were Indian silver-grey wood and Indian laurel. The demand for rosewood is chiefly for the Continental markets. Padauk, like most red woods, is temporarily out of favour.

Chooi (*Sageræa elliptica*) from the Andamans was tried for golf club shafts, but considered not to be competitive in price or specification with the American timbers used for the purpose.

One merchant tried a log of sissoo from Bengal, but did not find the timber attractive as a commercial proposition.

The reduced price has widened the uses of teak, which is much in evidence for garden frame work, seats in parks and outdoor purposes generally.

PROPAGANDA

Panels in Indian laurel and Indian rosewood, framed in Indian silver-grey wood, were added to the show windows at India House. The Imperial Institute added a diorama stand in Indian laurel from Madras to the Indian gallery. This wood yielded some beautiful figures panels.

An effective display of teak was staged by the principal Burma shippers of teak at the British Industries Fair at Olympia, and teak was prominent elsewhere at the Exhibition in the shape of garden furniture, cabinets and small articles.

The Timber Development Association continues its good work for the purpose of counteracting the insidious propaganda in favour of substitutes for timber. Amongst other activities it published a " Use Chart " for timbers in *The Architectural Review* for August, 1934. The timbers in the Chart include gurjun, Indian laurel, Indian silver-grey wood, Andaman marble wood, rosewood, satin wood, teak and thitka.

PROMINENT BUILDINGS IN WHICH INDIAN TIMBERS HAVE BEEN USED DURING THE YEAR

Window frames in teak, panelling in Indian silver-grey wood, and flooring in Andaman gurjan, were used in the replica of the King's House at the *Daily Mail* Ideal Homes Exhibition at Olympia.

Teak, Indian silver-grey wood and Indian laurel were used in the new building of the Royal institute of British Architects.

TIMBER

Extract from the Quarterly Report of the Indian Trade Commissioner, London, April—June 1935, and July—September 1935.

April—June 1935

The demand for teak continues and values remain steady. The demand for other Indian timbers during the quarter has been exceptionally poor. Price continues to be the main factor and ever-increasing use of plywood and veneers limits the use of the choicer hardwoods. Figured logs are always in demand but even

these are subject to changes in fashion and it is doubtful if it would pay India to attempt to cater for this market.

Imports to the United Kingdom of unmanufactured hardwoods from all sources of supply totalled 364,000 tons valued at £3,058,764 during the first six months of 1935 as against 346,500 tons valued at £2,873,590 during the first six months of 1934.

These included 18,760 tons of sawn teak from India valued at £332,350 in 1935 as compared with 13,620 tons valued at £243,337 for the corresponding period of 1934. Figures for the import of teak in the form classed as hewn and for other Indian timbers are not yet available.

Imports of plywood to United Kingdom continue to increase. During the first six months of 1935 they totalled 6,011,000 c.ft. valued at £1,686,000 as against 5,020,000 c.ft. valued at £1,379,922 in the first six months of 1934. Of this quantity British countries contributed only 12,752 c.ft. valued at £5,979 in 1935 and 17,581 c.ft. valued at £6,974 in 1934. The rest are of foreign origin.

July—September 1935

Imports of unmanufactured hardwoods from all sources of supply to the United Kingdom during the nine months, January to September 1935, totalled 572,000 tons valued at £4,670,000 as against 544,000 tons valued at £4,440,000 during the corresponding period of 1934. These figures include imports of sawn teak from India which increased from 19,500 tons valued at £349,600 during the first nine months of 1934 to 26,700 tons valued at £475,700 during the corresponding period of 1935. Figures are not yet available for the imports of teak in the form classed as hewn or for imports of other timbers from India.

Sales of timber through the agency of this office during the quarter were 250 tons and deliveries against previous sales were 170 tons.

Imports of plywood to the United Kingdom during the first nine months of 1935 were 9,052,000 c.ft. valued at £2,536,870 against 7,651,000 c.ft. valued at £2,035,350 during the corresponding period of 1934. Practically all this plywood is of foreign origin.

FOREST CONFERENCE AT DARJEELING

Mr. W. Meiklejohn, I.F.S., Conservator of Forests, Bengal, delivered the following Presidential address at a Forest Conference held at Darjeeling in October 1935 :—

GENTLEMEN,

Sir Nazim-ud-din has very kindly consented to open this Conference. As most of you know, since he assumed the duties of Hon'ble Member in charge of Agriculture and Industries, he has shown great interest in all our forest affairs and problems. I have only been here a short time but even in that period I have been able to benefit by his help and advice and to appreciate his fairness to all concerned.

Before I ask him to open the Conference I would like to say a few words about these Conferences and the present position of our department. The first Conference for several years was held last year at Rangirum. At that Conference you all seem to have done a lot of useful work. Most of the resolutions related to procedure and of those which required the sanction of Government most have been dealt with and decided one way or another. While those with which the Conservator could deal have been disposed of. You will have an opportunity later to hear what has been decided in each case. I would like to see these Conferences deal more with scientific subjects relating to Forestry and I hope we will gradually be able to effect this change.

During the year that is past the position of the department from the financial standpoint has improved a little. The revenue has been Rs. 17,32,000 with an

expenditure of Rs. 14,90,000. These are indications that this is not a mere flash in the pan but that the improvement is likely to be continued. We still require a much larger revenue before we can consider ourselves back in a normal position. Government have recognised this improvement and have been generous considering the general depression still prevailing.

There are one or two matters of outstanding importance to us at present. It seems to me that trade indications point to a very much greater demand for soft woods in the future, with a consequent falling off in the hard wood trade. This is a matter which must be gauged by the Forest Utilisation Officer and provided for by all Divisional Forest Officers aided by the Silvicultural Division. If my view is correct we must be ready beforehand and while reducing the cost of artificial regeneration to the minimum we must see to it that we have a sufficient supply of suitable species, capable of cheap and easy extraction.

We have concentrated our efforts during the past few years on our plantations, and have failed to give the high forest the attention it needs. This aspect of our work must not be overlooked in future.

Then there is the controversial question of departmental *versus* indirect exploitation; circumstances and figures must be closely examined, particularly overhead charges in departmental work, and a decision arrived at as to whether departmental operations really pay after they have achieved their primary object of creating a market. Elsewhere I have found that departmental exploitation in comparison with work through contractors seldom pays except under very special circumstances; whether such exist in Bengal I cannot yet say.

There is one branch of our work which particularly needs attention and that is the preparation of working plans. You all know the importance of these plans on which the management of our forests depends, and how necessary it is that they should be kept up-to-date. We must see that this branch of Forestry receives the attention it deserves in the future.

As regards our staff, the question of the revival of the second post of Conservator and the headquarters of the two Conservators is now before Government. It will be decided by them next April, so I need not say any more about that. Many of our subordinates who are really permanent men are still on a temporary basis. Government is fully aware of the position and I am sure our Hon'ble Member will do all he can for them when circumstances permit.

I will now ask Sir Nazim-ud-din to open the Conference.

Some of the resolutions passed at the Conference are given below :—

III.—UTILISATION.

(*a*) The future policy of the Utilisation Branch was discussed and it was resolved that soft woods should be grown in accessible and suitable localities, looking ahead for a period of at least 50 years. It was further resolved that *sal* (*Shorea robusta*) should be grown only on soil best suited to it and not necessarily in the more accessible areas.

(*b*) (*i*) The question of supplying existing markets with forest produce was discussed and it was resolved that in *North Bengal* soft woods should be grown in the hills together with any other species for which there is a special or local demand. This involves research by the Forest Utilisation Officer and Divisional Forest Officer, Silvicultural Division.

It was further resolved that the Divisional Forest Officers, Kurseong, Jalpaiguri and Buxa, should submit a list of areas suitable for species other than *sal* (*Shorea*

robusta) having due regard to rotations and to the fact that the areas under any one species must be sufficiently large to admit of economical exploitation.

(*ii*) In North Bengal the stock of soft woods with an established market is too small and scattered to justify an enumeration, or for the Forest Utilisation Officer to tender for the sale of these species.

(*iii*) Resolved that the Forest Utilisation Officer should collect data on the more common species in the North Bengal such as, *sidha* (*Lagerstrœmia parviflora*), *bahera* (*Terminalia belerica*), *simul* (*Bombax malabaricum*), *chilauni* (*Schima wallichii*), *kadam* (*Anthocephalus cadamba*), laurels, *lattar* (*Artocarpus chaplasha*), *parari* (*Stereospermum chelonoides*), *udal* (*Sterculia villosa*) and *mainakat* (*Tetrameles nudiflora*) going to Dehra Dun for the purpose, and that eventually he should publish a Bulletin on the subject. In the meantime Divisional Forest Officers, Buxa, Jalpaiguri, Kurseong and Kalimpong, should prepare estimates of cost of a complete enumeration of all species in selected areas.

In South Bengal estimates should be prepared for the enumeration of civit.

(*iv*) Resolved that the Forest Utilisation Officer should collect information regarding minor products.

(*c*) The question of the improvement of Sunkholas at Government expense was discussed and it was resolved that no action was necessary.

(*d*) The question of testing timber found in abundance for wider markets and new uses was discussed. It was resolved that this is already being done and no further species can be sent to Dehra Dun as they cannot undertake any more at present.

(*e*) The question of revision of schedules of rates for timber was discussed. It was resolved that as Divisional Forest Officers have already the power to raise, or lower, existing rates by 50 per cent. no further action is required.

IV.—SILVICULTURE.

(*a*) The question of separation of species on different rotations was discussed and it was resolved that while the locality governs, to a large extent, the choice of species, yet it is inadvisable to have small segregated patches of species with widely differing rotations, uses and resistance to fire, the Silviculturist should, however, try to evolve a series of standard mixtures classified according to rotations, uses, locality and resistance to fire.

(*b*) The question as to whether species should be grown in mixtures or not was discussed. It was resolved that with the exception of gregarious species, mixtures are most desirable.

(*c*) The question as to whether certain fast growing soft wood species should continue to be grown was considered and it was resolved that definite working circles for match woods and box woods should be formed and that they should preferably be situated where river or other means of transport is easy. These working circles should be sufficiently large to attract factories to the locality. That elsewhere in North Bengal where miscellaneous species are grown the aim should be to produce the more valuable timbers and let South Bengal provide the bulk of the match and box woods.

(*d*) The question of the advisability for the revision of the calculation of the yield for *sal* (*Shorea robusta*) was considered and it was resolved that no action need be taken until the intermediate revision of existing working plans takes place.

(*e*) After discussion as to the merits of artificial regeneration versus natural regeneration in the Chittagong Divisions, the matter was referred to a Sub-Committee to suggest a policy for the future management of these forests.

V.—WORKING PLANS.

(*a*) (*i*) The existing Compartment History Form was considered in relation to subsidiary forms and it was decided that they should be correlated; a Sub-Committee was appointed to look into the matter.

(*ii*) The question of the check of Control Forms which are in arrear was also discussed. It was decided that this check may be postponed until the Working Plan Officer can take the matter up, but that the current forms must be checked by him.

(*b*) The question as to what areas should be shown in the Annual Report for partly worked, selection and dry fellings, was considered. It was resolved that the whole area sold should be shown and a note made if necessary, to show that the area has not been fully worked. It was further resolved that the heading of column 5 of the new Control Form A1 should be altered to "sold during the year."

(*c*) The naming of Selection Felling Coupes was discussed and it was resolved that the year and number of a coupe should be that in which it is sold; also that no alteration in the year and number should be made if it is put up for sale in any subsequent year.

(*d*) The question of the opening of a Forest Publicity Section under the Forest Utilisation Officer was discussed, and it was decided that a Publicity Officer should be attached to him to publish information about the Department throughout the Province.

(*e*) The misuse of the term "Selection Felling" was discussed and it was resolved that in future we adhere strictly to the terms in the "Glossary of Technical Terms."

VI.—FINANCE.

Discussion of Revised and Budget Estimates.—Nothing was decided in Conference owing to absence of Conservator of Forests.

(Mr. E. A. C. Modder, Deputy Conservator of Forests, in the Chair.)

VII.—GENERAL.

(*a*) The Conference was informed of the action taken on the resolutions of the Conference of 1934-35.

(*b*) and (*c*) The question of the revision of the Bengal Presidency Forest Manual and the preparation of a Manual of Standing Orders was considered. It was resolved that an officer be specially deputed to revise the former and compile the latter.

It was further resolved that when the compilation of the Manual of Standing Orders was taken in hand, a supplement be compiled for each Division.

(*d*) The question of control of the number of wild elephants in the Chittagong, and Chittagong Hill Tracts Districts was discussed. It was decided that no resolution was necessary as arrangements have already been made for the leasing of elephant *mahals*.

(*e*) The question of making rewards to Forest subordinates for the detection of forest offences was discussed, but no resolution was considered necessary as the existing rules are quite clear.

(*f*) The question as to the form in which security of subordinates and contractors should be made was discussed and it was resolved that—

(*i*) in the case of subordinates Post Office Savings Bank deposits only will be accepted and that as existing Post Office Cash Certificates mature the amount should be put into the Post Office Savings Bank ; and

(*ii*) in the case of contractors no action is necessary in view of rule 182 of the Bengal Financial Rules.

(*g*) The question of co-ordination of sales of timber inter-divisionally was discussed and it was resolved that an attempt be made to improve the distribution of information as regards the sale of forest produce.

(*h*) The question of departmental extraction of timber was discussed ; it was decided that departmental extraction should be discouraged once a market has been established.

(*i*) (*a*) The existing fixed demand permit form was discussed and it was decided that as the permit fee is payable in advance conditions 11 and 12 are redundant, but a clause showing the realisation of the fee should be added.

(*b*) In this connection the question of accrual of rights in a reserved forest arose. It was decided that the question as to whether a right may be acquired in a reserved forest in spite of section 23 of the Indian Forest Act should be again put up to Government for a clear decision.

(*j*) The question of forest villages and the grazing of village and contractors cattle was discussed. No resolution was considered necessary.

(*k*) The question of Parliamentary Commission figures (Future programme of work in connection with the New Constitution) could not be discussed owing to the absence of Conservator of Forests.

(*l*) The question of the supply of the complete *Calcutta Gazette* to Divisional Forest Officers was considered and it was resolved that Government be moved to arrange the supply.

(*m*) and (*n*) The question of the representation of Forest Officers on public bodies was discussed and it was resolved that Government in the Local Self-Government Department be approached to provide for the representation of Forest Officers on public bodies and committees as for example—

(*i*) Divisional Forest Officers on District Board and Municipalities,

(*ii*) Range Officers in Local Boards,

(*iii*) Beat Officers on Union Boards,

so that the Forest Department may keep in touch with local administration.

(*o*) This deals with travelling allowance of officers—the Conference came to no decision and the case was withdrawn.

(*p*) The question of the adoption of model rules for the maintenance of inventories of Government stores, tools, etc., was discussed. It was decided that the existing forms are suitable.

(*q*) The proposal to set up booms at Sevoke was rejected.

(*r*) This deals with the provision of funds for travelling allowance of subordinates—this was discussed but the case put up by the representative of the subordinates was not sound. So no resolution was made and the case was withdrawn.

(*s*) The question of the revision of security bonds for subordinates was discussed. The Conference was informed that rules are under the consideration of Government.

The following information is extracted from the Seaborne Trade and Navigation of British India for March 1936 :—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY					
	MONTH OF MARCH			TWELVE MONTHS, 1ST APRIL to the end of MARCH		
	1934	1935	1936	1933-34	1934-35	1935-36
WOOD AND TIMBER						
Teak wood—						
From Siam .. cubic tons	200	..	..	10,253	3,794	277
,, French Indo-China ,,	926	1,649	122	1,251	4,748	547
,, Other Countries ,,	..	..	..	..	..	10
Total .. ,,	1,126	1,649	122	11,504	8,542	834
Firewood .. .. ,,	57	18	66	766	586	506
Sandal-wood .. .. ,,	11	25	9	340	292	213
Sleepers of wood for railways .. .. ,,	..	..	..	6	..	..
Other kinds of wood and timber .. .. value	..	..	..	..	..	..
Manufactures of wood, *other than* furniture and cabinet-ware ,,	..	..	..	..	..	..
Total of Wood and Timber ,,	..	..	..	..	..	..

EXPORTS

PRINCIPAL ARTICLES	1934	1935	1936	1933-34	1934-35	1935-36
WOOD AND TIMBER						
Teak wood—						
To United Kingdom cubic tons	3,765	6,593	5,223	16,631	29,352	39,385
,, Germany .. ,, ,,	228	546	219	1,239	2,321	4,587
,, Netherlands .. ,, ,,	68	65	8	425	508	451
,, Ceylon .. ,, ,,	23	168	284	621	949	1,524
,, Union of South Africa .. ,, ,,	594	917	807	3,656	3,630	3,695
,, Portuguese East Africa .. ,, ,,	2	429	238	321	737	2,028
,, United States of America .. ,, ,,	34	477	53	527	1,051	469
,, Other Countries ,, ,,	447	479	941	3,318	4,559	6,103
Total .. ,, ,,	5,161	9,674	7,773	26,738	43,107	58,242

IMPORTS

PRINCIPAL ARTICLES	VALUE					
	Month of March			Twelve months, 1st April to the end of March		
	1934	1935	1936	1933-34	1934-35	1935-36
	R	R	R	R	R	R
Wood and Timber						
Teak wood— From Siam	21,551	..	..	10,11,000	4,14,751	26,616
„ French Indo-China ..	54,849	1,18,676	15,717	92,302	3,78,282	65,196
„ Other Countries ..	..	..	..	..	89	868
Total	76,400	1,18,676	15,717	11,03,302	7,93,122	92,680
Firewood	855	270	990	11,464	12,787	7,497
Sandal-wood	2,407	13,429	1,450	1,35,495	1,01,847	74,664
Sleepers of wood for railways	..	..	24	612	..	24
Other kinds of wood and timber	2,64,545	3,22,516	1,62,791	26,83,641	24,75,481	25,92,215
Manufactures of wood, *other than* furniture and cabinet-ware	1,28,302	2,05,348	1,91,661	14,65,593	22,95,873	25,60,442
Total of Wood and Timber ..	4,72,509	6,60,239	3,72,633	54,00,107	56,79,110	53,27,522
EXPORTS						
Wood and Timber						
Teak wood—						
To United Kingdom	9,31,394	12,40,523	10,29,232	39,23,878	61,86,003	76,41,719
„ Germany	54,621	1,31,848	42,122	3,19,806	5,65,457	10,40,232
„ Netherlands..	12,663	9,131	1,199	70,112	89,436	83,266
„ Ceylon	2,367	30,728	32,458	84,868	1,35,952	1,94,702
„ Union of South Africa ..	1,43,610	1,93,691	1,70,396	9,05,758	7,87,293	6,61,997
„ Portuguese East Africa ..	310	75,218	35,178	69,734	1,29,006	3,26,793
„ United States of America..	6,023	1,20,666	15,901	1,16,558	2,79,878	1,16,321
„ Other Countries	96,198	82,883	1,22,517	6,39,947	8,68,198	11,07,451
Total ..	12,47,186	18,84,688	14,49,003	61,30,661	90,41,223	1,11,72,481

EXPORTS—(contd.)

PRINCIPAL ARTICLES	QUANTITY					
	MONTH OF MARCH			TWELVE MONTHS, 1ST APRIL to the end of MARCH		
	1934	1935	1936	1933-34	1934-35	1935-36
WOOD AND TIMBER Teak wood— Share of Bengal ..cubic tons	..	..	..	7	10	21
,, Bombay .. ,, ,,	151	112	126	1,417	1,946	1,493
,, Sind .. ,, ,,	..	..	..	26	1	3
,, Madras .. ,, ,,	53	130	209	164	322	284
,, Burma .. ,, ,,	4,957	9,432	7,438	25,124	40,828	56,441
Total .. ,, ,,	5,161	9,674	7,773	26,738	43,107	58,242
Teak Keys .. tons	376	976	634	3,585	4,137	4,893
Firewood .. ,,	..	..	2	239	132	68
Hardwood (*other than* teak)—						
To United Kingdom cubic tons	62	108	251	528	643	972
,, Other Countries ,, ,,	1	4	9	100	95	92
Total .. ,, ,,	63	112	260	628	738	1,064
Sandal— To United Kingdom .. tons	10	..	..	264	32	37
,, China (*excluding* Hong-Kong) .. ,,	10	10	..	85	61	30
,, Japan .. .. ,,	15	7	..	123	96	112
,, Anglo-Egyptian Sudan ,,	2	5	1	49	53	66
,, United States of America .. .. ,,	100	24	50	422	412	569
,, Other Countries .. ,,	3	3	3	45	21	48
Total .. ,,	140	49	54	988	675	862
Other kinds of wood and timber .. .. value	..	..	..	..	..	..
Manufactures of wood, *other than* furniture and cabinetware .. .. ,,	..	..	..	..	..	..
TOTAL OF WOOD AND TIMBER AND MANUFACTURES THEREOF ,,	..	..	..	..	..	..

EXPORTS—(contd,)

PRINCIPAL ARTICLES	VALUE					
	MONTH OF MARCH			TWELVE MONTHS, 1ST APRIL to the end of MARCH		
	1934	1935	1936	1933-34	1934-35	1935-36
WOOD AND TIMBER	R	R	R	R	R	R
Teak wood—						
Share of Bengal	..	..	25	1,500	1,430	5,366
,, Bombay	35,825	22,051	25,167	3,13,673	3,67,709	2,80,163
,, Sind	36	..	..	7,164	466	340
,, Madras	2,997	8,364	14,085	15,240	24,504	21,336
,, Burma	12,08,328	18,54,273	14,09,726	57,93,084	86,47,114	1,08,65,276
Total	12,47,186	18,84,688	14,49,003	61,30,661	90,41,223	1,11,72,481
Teak Keys	56,345	1,46,400	91,800	5,15,811	6,13,150	7,23,499
Firewood	..	8	20	3,391	2,411	907
Hardwood (*other than* teak)—						
To United Kingdom	5,890	10,933	25,150	63,912	63,538	1,03,372
,, Other Countries	98	412	1,505	11,933	10,501	10,487
Total	5,988	11,345	26,655	75,845	74,039	1,13,859
Sandal—						
To United Kingdom	13,100	..	..	3,14,163	39,586	42,276
,, China (*excluding* Hong-Kong)	16,160	15,507	..	1,25,766	94,772	42,690
,, Japan	9,882	8,925	..	1,28,710	1,01,794	1,21,777
,, Anglo-Egyptian Sudan ..	2,230	5,310	1,350	53,950	56,685	85,065
,, United States of America	1,20,000	24,069	59,000	5,63,345	4,72,869	5,78,090
,, Other Countries	4,245	3,052	3,167	64,188	36,030	55,443
Total	1,65,617	56,863	54,517	12,50,122	8,01,736	9,25,341
Other kinds of wood and timber	42,359	52,053	92,138	2,45,647	3,72,810	4,07,728
Manufactures of wood, *other than* furniture and cabinet-ware	28,314	12,896	17,538	2,02,667	1,21,901	1,13,003
TOTAL OF WOOD AND TIMBER AND MANUFACTURES THEREOF ..	15,45,809	21,64,253	17,31,671	84,24,144	1,10,27,270	1,34,56,818

WOOD WINS AGAIN

Darlington Town Council on Thursday of last week discussed wood *versus* steel window frames. Wood won the day, and the discussion was notable for the testimony to wood paid by practical men in the building trades. The Housing Committee had recommended the provision of wooden stormproof easements for 16 new council houses, and an amendment was moved that steel window frames be used, the proposer declaring that a large number of local men were employed in rollingsections for the making of steel window frames, and he felt that local industry should be supported. Against this, another councillor said that the manufacture of wooden window frames in Darlington provided more work than the manufacture of metal frames. When the discussion got up to the right level, namely, fitness for purpose, there was the assertion of Councillor Richardson, a practical builder, that the wooden frames were superior and carried a guarantee ; and mention was made of the fact that at Keighley steel window frames had been taken out of houses after only seven years' use. Councillor Trees added his opinion as a joiner ; wooden frames, he said, had a 50 per cent. longer life than metal frames. Metal frames, he added, were being taken out of buildings at Catterick Camp. In the end the amendment was lost, and wooden window frames will be fitted. (*Timber Trades Journal and Sawmill Advertiser*, 14*th March* 1936).

PROTECTION OF WILD LIFE IN AFRICA

The Convention for the Protection of the Fauna and Flora of Africa, signed on behalf of nine Governments in London on November 8, 1933, became effective on January 14, 1936. The ratified articles have therefore come into force in all the African territories of Great Britain, Belgium, Egypt, the Anglo-Egyptian Sudan and the Union of South Africa (Science Service, Washington, D. C.). As a result, gorilla, okapi, white rhinoceros, pigmy hippopotamus and 18 other rare wild animals, together with the unique plant of the Kalahari Desert, *Welwitschia*, are now absolutely protected. Protection almost as complete is afforded to a series of animals in List A which may not be killed for ordinary purposes at all either by natives or whites, but may be taken in strictly limited numbers, with Government permission, for important scientific purposes. There are included such African elephants as possess tusks less than 10 pounds in weight. If the tusks be heavier than 10 pounds, the elephants fall into Class B where they are partnered by black rhinoceros, the two species of giraffe, the wild ostrich and several kinds of egrets and hornbills. Class B animals may be hunted only by special licence, whereby the area, time and extent of the hunting is strictly limited and defined.—(*Nature*, 11th April 1936.)

INDIAN FORESTER

AUGUST, 1936

EDITORIAL : PRIVATE FORESTS CONTROL

The preservation and development of private forests depend of course primarily on the landowners themselves, the interest taken by them in the matter, and their capacity for action. It has, however, been found by experience, not only in India but also elsewhere, that even if the landlords possess the necessary professional skill, which is rarely the case, the measures which they can take on their own initiative can seldom if ever be sufficient in all respects for the proper management of their forests. For this reason it has always been regarded as a duty of the State to steer the development of this branch of economy in the right direction and to support private efforts to that end. The forests form a valuable asset to every country and the various countries have applied different methods to suit their local conditions for the management of their private forests. We propose to discuss here very briefly as to what Finland has done to preserve its private forests, a subject dealt in a pamphlet "Main Features of Finnish Forestry."

Finland is richer in forests than any other country in Europe if we take the relative area of forests as the basis of comparison, and the second richest if the absolute area of forests is taken into account. According to a recent survey of the natural forest resources the area of forests is almost three-quarters of the total land of the country and is divided between the various classes of proprietors as follows :—

State	39·7 %
Private	52·1 %
Wood-working Companies	6·4 %
Communal	1·8 %
	100·0 %

When it is remembered that 80—85 % of the total value of exports from Finland consist of forest products most of which come from private forests the importance of the latter at once becomes obvious.

It will therefore be seen that the management of private forests in Finland is of such significance that its continued development is a matter that concerns not only the individual owners, but the whole community as well.

The Government realized this fact and when on enquiry they found that the private forests were actually being overfelled they at once took action which consisted, firstly, of forest legislation and, secondly, of setting up of local " Forest Boards " consisting mostly of the landowners. The private Forest Law governs the management of private forests and the provisions are simple and straightforward without the complications which are usually found in legal documents. We will here quote one provision of the Finnish Private Forest Law. It says " Forests shall not be destroyed ; forest shall therefore not be cut in such a way or the land left after cutting in such a state or be so utilized as to endanger the natural regeneration of the forest," and then follow other sections as to how this end can be secured. There is a general order that makes the previous reporting of cuttings compulsory especially of those which are meant for purposes of sale. The law also contains detailed stipulations as to the measures to be taken when a forest has been destroyed or when a duly approved working plan has been transgressed, and as to the penalties involved. This law is mainly based on the regeneration principles, as for instance in the case of fellings intended to supply the landowners' domestic requirements for timber, etc., the only restriction laid down is that the natural regeneration of the forest shall not be endangered.

The State, however, was not content with legislation only. In the words of the authors " the Local Forestry Boards—which control the observance of the Private Forest Law—shall also promote private forestry, by disseminating knowledge of rational forestry, by guiding and assisting the carrying out of silvicultural measures, by promoting

and supporting joint action concerned with forestry." These Local Forest Boards are free to arrange their own affairs as they desire. Their work is, however, co-ordinated by the Central Forest Societies. The State Board of Forestry—an official body—leaves the Local Boards and the Central Societies alone except that it exercises general supervision when they disburse Government money placed at their disposal for distributing as subsidies for the improvement of private forests. It is claimed that these local bodies have done an enormous amount of good work in promoting private forestry and have not only checked over-exploitation but have actually improved the private forests. Government legislation alone might or might not have succeeded without the co-operation of forest owners, but it is a pleasure to see the State and the public co-operating as they have done in Finland in saving and improving their private forests. Our main object in dealing with this subject is to see how far we have succeeded in getting the co-operation of the public in maintaining private forests in India. We will take the case of Bihar and Orissa. It is well known that denudation on the Chota Nagpur plateau has been going on for a long time as a consequence of which there has been erosion on a large scale and overspilling of banks. The free and cheap supply of wood was becoming scarce, and the grazing area was diminishing which entailed suffering for the cattle.

The Local Government, purely from a humanitarian point of view, to save the people from the misery which threatened the latter if the hillsides were laid bare, prepared two Private Forest Bills, one in 1905 and another at a later date, to save what was left of the private forests, but on account of want of assured majority in the Council these Bills had to be dropped. Government even offered to buy up important blocks of forests but the landowners refused to sell their forests or to manage them properly. Finally Government had to lease suitable forests where owners agree, for about 40 years, to pay the cost of management and an annual rent of one to two annas an acre, and to share the profits if any. It may be said that there will be no profits for the greater part of the lease and Government will have to pay out more than Rs. 40,000 annually for the management

of some 80,000 acres or so. At the end of the period of the lease Government will hand back the forests to owners in a very much improved condition. The conditions are entirely in favour of the owners who will not have to spend a single farthing on the management of their forests with an annual rental assured to them. It will be seen that the Bihar and Orissa Government was not moved to manage private forests from a financial point of view as was the case in Finland, but purely, as it has been said above, from the point of view of an humanitarian, but the people would not co-operate. Efforts are being made to organise forest associations, to establish forest nurseries, and to disseminate forestry knowledge by articles in papers and lectures in schools and villages to create "forest sense," but it must be confessed that the process is slow. It is doubtful that either Bihar and Orissa or any other province in India will ever reach the stage which Finland has reached in the development of private forestry. The only element, and which is most important, lacking in India is that the forest owners will neither co-operate with one another nor will they co-operate with Government, as they do in Finland. It is a pity, but we will persevere.

SAL NATURAL REGENERATION EXPERIMENTS IN THE UNITED PROVINCES*

By E. C. Mobbs, M.A., B.Sc., I.F.S.,

Deputy Conservator of Forests, U. P.

Under the Research Programme for the 5 years 1931—36 special attention is being paid to the problem of *sal* (*Shorea robusta*) natural regeneration. On the basis of results from earlier and current experiments (including some particularly valuable divisional experiments in the Haldwani and Ramnagar divisions), a comprehensive scheme of systematic detailed experiments was drawn up. The more important parts of this scheme, dealing with the valuable medium and moist submontane (*Dun* and *Bhabar*) *sal* types have been put into operation,

*This article was written by Mr. Mobbs when on leave. He had not seen the article by Mr. Smythies on *Sal* in the April issue when this was written.—S. H. Howard.

partly with existing experiments reorganised according to the new scheme, and partly by the laying out of entirely new experiments.

The nature of the probem is such that most of the experiments will probably extend over a period of 10 or more years. It must be emphasised that they must be allowed to run their course according to plan. It would be unwise and perhaps even dangerous to attempt to draw conclusions too soon or to base any large-scale forest management on provisional conclusions from immature experiments. At the same time it has to be noted with satisfaction that some of the experiments are already beginning to show interesting and promising results, which justify the conclusion that we are at least working in the right direction, and are perhaps much closer than we have ever been before to a solution of the problem of *sal* natural regeneration. The following general account is intended simply to indicate to Divisional Forest Officers and others the directions in which the research work is proceeding.

The chief experiments now in progress may be divided into three main groups—

A.—Various degrees of burning (with protected and shrub-cut controls) under various canopy conditions, deer-proof fenced and unfenced or cattle-fenced.

B.—Various degrees of shrub-cutting under various canopy conditions, with deer-proof fencing and protection from fire (except for general burning after fellings at the initiation of the experiments).

C.—Intensive clear weeding throughout the hot weather and rains in deer-proof fenced and unfenced plots, some clear-felled and others under various canopy conditions.

The experiments in groups A and B are on a large scale, varying from 45 to 100 acres per experiment, the smallest sub-plots being approximately 5 acres each. The results obtained should therefore be capable of practical application on a larger scale in general forest management. The experiments in group C are on a small scale, from half an acre to as little as 1/10th of an acre per plot. They are essentially research plots, not intended to be copied on a large scale,

and as is pointed out later they are actually the research experiments leading up to the larger scale experiments in group B.

The following is a brief summary of the experiments in each group—

A.—*Various degrees of burning under various canopy conditions, deer-proof fenced and unfenced or cattle-fenced.*

(1) Haldwani Expt. 16; Lakhmanmandi compt. 4, 45 acres, 10 sub-plots.

(2) Haldwani Expt. 17; Sela compt. 4, 99 acres, 18 sub-plots.

(3) Ramnagar Expt. 6; Lachampur compt. 2, 55 acres, 8 sub-plots.

(4) Ramnagar Expt. 7; Bhakra compt. 3; 60 acres, 12 sub-plots.

(5) Pilibhit Expt. 5 (half); Chuka compt. 48; 75 acres, 6 sub-plots.

Although the first four of these were the first experiments to be laid out under the present research programme, and their full organisation was completed in 1933-34, it will be some years before they even reach the stage when differential burning can begin. Organisation of Pilibhit Expt. 5 has only been completed in 1935.

As the initial conditions of the experiments were different, they have responded in different degrees to the similar treatment. Haldwani 17 perhaps shows the results to date most clearly. Here the various degrees of felling have been followed by a proportional development of grass—from heavy grass in the heavy felled plots to light grass in the light felled plots. *Sal* natural regeneration, both pre-existing and from the 1933 seedling year, is distinctly better in the fenced than in the unfenced plots for all degrees of felling; and it is better in the moderately felled plots than in the light and heavy felled plots. Open patches in the light felled plots have good *sal* regeneration, comparable to that in the moderately felled plots, the canopy conditions being more or less the same.

Similar general results are observable in the other experiments, but owing to damper conditions, evergreen and semi-evergreen undergrowth is more prevalent. In Haldwani 16 the burning is

already reducing the former heavy undergrowth, and regeneration in the fenced heavy and moderately felled plots is developing well. But in Ramnagar 6, owing to a poor burn in 1934, it was necessary to cut shrubs before burning could be done in 1935.

B.—*Various degrees of shrub-cutting under various canopy conditions, with deer-proof fencing and fire-protection.*

(1) Haldwani Expt. 18; Sela compt. 4; 70 acres, 12 sub-plots.

(2) Haldwani Expt. 19; Sunmanthapla compt. 1; 100 acres, 6 sub-plots.

(3) Pilibhit Expt. 5 (half); Chuka, compt. 48; 75 acres, 6 sub-plots.

The two Haldwani experiments were completely organised and differential shrub-cutting was commenced in 1934. In the Pilibhit experiment, differential shrub-cutting was commenced in the rains of 1935.

These experiments provide similar treatment under different initial conditions. All had a certain amount of *sal* regeneration present to begin with, but not enough to stock the area completely. In Haldwani 18 a very good seed-year in 1933 covered the ground with *sal* seedlings *before* fellings were carried out. The fellings followed immediately in the cold weather of 1933-34, and in March and April 1934 the whole experiment was shrub-cut and burnt, although the profuse new *sal* regeneration was only 9 months old. Rains shrub-cutting was done in some of the plots in July 1934 and again in August 1935. Cold weather shrub-cutting was done in some of the plots in January and February 1935. The allotment of plots is such that some are shrub-cut only in the cold weather, some only in the rains, and some at both times.

The response of the *sal* regeneration to this treatment has been remarkable, the plots shrub-cut in the rains being now mostly covered with dense *sal* seedlings, which by August 1935 had already reached 2 ft. to 5 ft. high.* The accompanying photograph was

*I inspected this plot with Mr. Mobbs last rains and I cannot help feeling that two points are not as clear as they might be. Where he says regeneration "had already reached two feet to five feet," it would, perhaps, have been better to say "had already reached five feet" because all sizes up to five feet are represented in the plot, that is to say, there are plenty of plants below two feet.—S. H. HOWARD.

taken in June 1935, and is typical of almost the whole area of the plots shrub-cut in the rains. That these are very largely 1933 seedlings, which have shot up as a result of the treatment, is evident from the fact that the densest and best regeneration is in those plots selected for moderate fellings (as opposed to heavy fellings), on account of a deficiency of older regeneration.*

Haldwani 19, subjected to the same treatment, had comparatively few 1933 seedlings, while at the same time there were considerably more evergreen and semi-evergreen shrubs in the undergrowth. While the treatment has obviously benefited the older regeneration and such new seedlings as existed, the regeneration is not nearly so dense as in experiment 18. It will be interesting to see the effect of the treatment on the new regeneration of the next seedling year, *i.e.*, on regeneration coming in after systematic differential shrub-cutting has been carried out for some time. The same also will be the case in Pilibhit 5. Here there is a moderate amount of older regeneration, but it will require supplementing at the next seedling year.

Until all these experiments have been allowed to run for several more years, it would be unwise to form any conclusions or to attempt to analyse the factors, initial and applied, that appear to affect the development of the regeneration. But progress so far is sufficient to warrant a spirit of hopefulness and a feeling that the experiments are being carried out in the right direction.

C.—*Intensive clear-weeding throughout the hot weather and rains in deer-proof fenced and unfenced plots, clear-felled and under various canopy conditions.*

(1) Haldwani Expt. 20; 2 plots situated inside Expt. 18 (both new).

(2) Ramnagar Expt. 8; 2 plots situated inside Expt. 6 (one new and one an old indicator plot).

* Next Mr. Mobbs was careful to tell me that though much of this regeneration appeared to be from the 1933 seed, which he deduced from the increase in the general density of regeneration, yet he did not pretend that all of it or the biggest plants were from the 1933 seedlings. Though this is not perhaps clear from his present wording, especially that on the illustration, there is no doubt that he does not pretend that it is all from the 1933 seedlings, because his own original record shows that there were a large number of seedlings *before* the 1933 seed-year and there is no suggestion anywhere that these have disappeared.—S. H. HOWARD.

SAL (SHOREA ROBUSTA) NATURAL REGENERATION

REGENERATION MOSTLY OF THE 1933 SEEDLING YEAR, WHICH HAS DEVELOPED AFTER A MODERATE FELLING OF OVERWOOD (COLD WEATHER 1933/34), SHRUB CUTTING AND BURNING (MARCH TO APRIL 1934) AND FURTHER SHRUB CUTTING (RAINS 1934 AND COLD WEATHER 1935)

Expt. 18, Haldwani Division (Sela Compt. 4). (Plot 18. 12.)

Photo : E. C. Mobbs, June, 1935.

(3) Ramnagar Expt. 3; 5 old indicator plots which formerly comprised old Expt. 3.

(4) North Kheri Expt. 9; 5 old indicator plots of Expts. 6 and 7, and 2 new control plots.

These experiments, which were commenced in 1933, are short-term ones, comprising old indicator plots of about 1/10th of an acre each and new plots of about half an acre each. These plots already contained some *sal* seedlings of various ages and sizes, from a few inches to 2 or 3 feet high (up to 5 or 6 feet in Haldwani 20). They were cut back and burnt in April 1933 and have been kept clear-weeded from April to October in 1933, 1934 and 1935.

The development of the *sal* regeneration in Haldwani 20 and Ramnagar 8 has been extremely good. The old seedlings have shot ahead and maintained the growth without check; dense groups in Haldwani 20 were up to 11 ft. high in August 1935. But even more phenomenal has been the development of the 1933 *sal* seedlings, which covered the ground in both experiments. They developed straight away and by August 1935 formed a dense mass 2 ft. to 5½ ft. high, all the better seedlings 3 ft. to 5½ ft. having already good stout woody stems. A few old trees were standing in the plots. The seedlings immediately beneath these were so markedly poorer than the rest that the trees were felled in all except one plot of Haldwani 20, which has been left as it was for comparison.

In Ramnagar 3, the 1933 seedlings were all removed and only the old ones retained. These have developed very well in the fenced clear-felled plot, moderately well in the fenced plots with an overwood, but very poorly in the unfenced plots, whether with or without an overwood.

In the N. Kheri plots, 1933 was not a good *sal* seedling year; results are therefore less phenomenal than in Haldwani 20 and Ramnagar 8, but are still good, following generally those of Ramnagar 3.

These experiments are being continued and final conclusions cannot be drawn yet. But one is justified in saying tentatively that clear-weeding throughout the hot weather and rains, *combined with protection from deer,* results in an immediate development of

both old and new *sal* seedlings, much more distinctly marked in the second year than in the first year, and that this development is better with complete overhead light than with even a light canopy.

From the practical point of view, clear-weeding on a large scale would probably be possible or desirable in rare instances only. But these small-scale experiments on the 1/10th to ½ acre scale indicate the direction in which development of *sal* regeneration may be obtained. The rains shrub-cutting experiments, described under group B, are the practical application of these small-scale clear weeded experiments over large areas and with a greatly reduced scale of weeding. In these, however (and also in the burning experiments), some degree of canopy has been left in all plots, and is probably essential, since the treatment is not sufficient to reduce the heavy grass which would develop if there were only a very light canopy or no canopy at all. It remains for these experiments to show exactly what degree of canopy and shrub-cutting is required, relative to other conditions, and to what extent results are dependent on initial conditions and other incidental factors.

In addition to the new and reorganised experiments, there are certain older *sal* regeneration experiments still being maintained by the Silviculturist, and also several divisional experiments under the direct control of Divisional Forest Officers, which are yielding valuable additional information. Of the older Silviculturist's experiments, the small plots comprising Haldwani 8 and N. Kheri 4 show the continued development of *sal* regeneration with deer-proof fencing and complete overhead light, combined in Haldwani 8 with shrub-cutting. Of the divisional experiments, the most interesting and profitable is probably Haldwani Divisional Expt. 4 (Sela compt. 3) in which the Silviculturist has his "watching brief" experiment Haldwani 13. This experiment has demonstrated the development of *sal* regeneration in a deer-proof fenced area with a moderately open canopy. The lighter the canopy the better the development, but also the greater the development of accompanying miscellaneous shrubs and weeds. Shrub-cutting has been shown to be very beneficial to the *sal* regeneration, which once established has developed best in the clear-

felled and shrub-cut plot. In this plot, the average height of 100 measured seedlings increased from 3′—6″ in February 1932 to 8′—1″ in February 1935, whereas in other plots with different degrees of over-wood the average height was 5′ to 5′—9″ in the same period with approximately the same start. The greater part of this experiment is rapidly approaching the stage when the *sal* regeneration must be regarded as undisputably completed. The treatment has been decided on from time to time according to the apparent silvicultural requirements. The adjacent Silviculturist's experiments 17 and 18 are to some extent repeating the operations, but with a much greater variety of conditions and with definitely prescribed methods of treatment and properly recorded controls, so that the effects of initial and applied conditions can be systematically evaluated.

* * * * * * *

SUMMARY

Under the Silvicultural Research Programme for the United Provinces, special attention is being paid to the problem of *sal* natural regeneration.

An account is given of the chief experiments now in progress, classified into three main groups—

A.—Variations of burning, canopy and fencing ;

B.—Variations of shrub-cutting and canopy, with fencing and fire-protection ;

C.—Intensive clear-weeding, with variations of fencing and canopy.

The nature of the problem is such that the experiments must be allowed to run for some years to come, but some are already beginning to show interesting results, which justify the conclusion that the experiments are being carried out in the right direction.

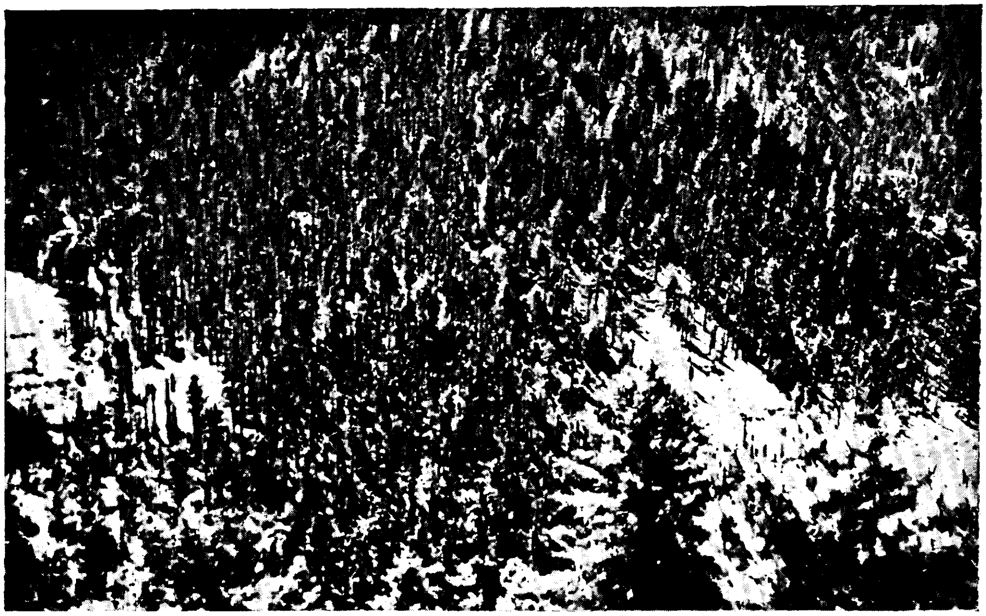
The account gives the progress of the experiments up to the end of August 1935.

MANDI STATE AND ITS FORESTS

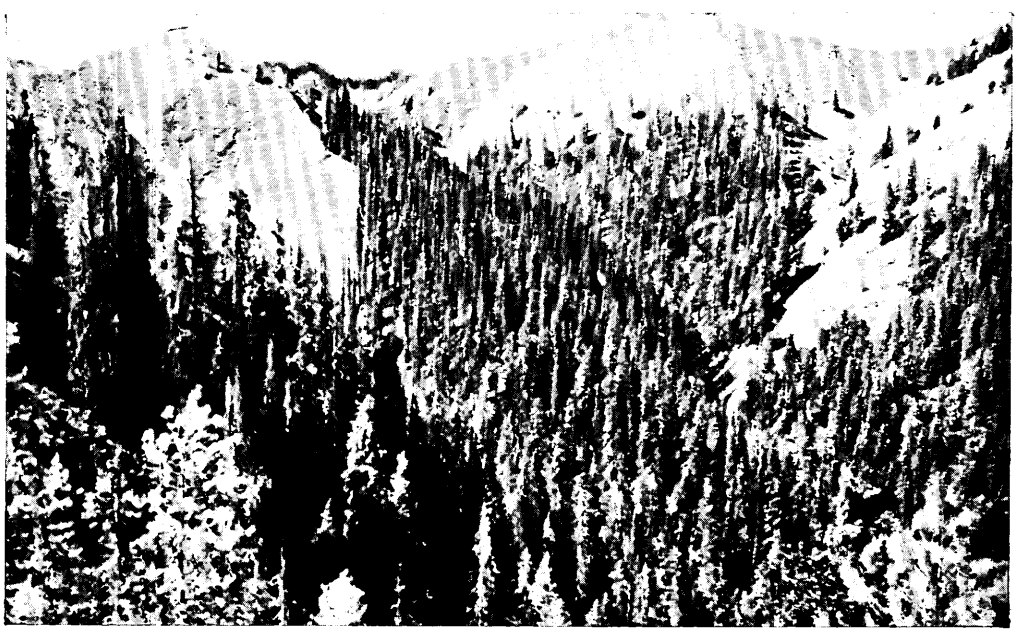
BY R. MACLAGAN GORRIE, D.SC.

Mandi is the premier hill state of the Punjab and lies astride the Beas valley west of Kulu and east of Kangra district. It is a fascinating place from the human point of view because it forms an epitome of the most ancient and most modern in Indian life. It has been so cut off from India by its own great mountain ranges that the people treasure many of the ancient customs which have already disappeared from the more easily accessible parts of Northern India, but in the midst of this undisturbed mediævalism we find the headworks of the Uhl valley hydro-electric project with its atmosphere of ultra-modern development and accompanying advantages of electric light and power.

The state forms a diamond shape of over 1,100 square miles, the chief features being a series of north to south ridges of over 10,000 feet, all of which are cut through by the Beas in its east to west passage through some very striking rocky gorges. The only town of any size is Mandi itself, a familiar halt for those who travel the Pathankot-Kulu motor road. But this capital has only 7,000 inhabitants and the remainder of the state's population of 200,000 is purely agricultural and scattered in small hill villages. To the motorist passing through on the Kulu road the country seems to be almost destitute of forest, for the lower slopes of the Beas gorge and the southern face of the Dhauladhar spurs are both pretty bare. There is, however, a very fine forest estate, more or less inaccessible to the ordinary sightseer owing to the complete absence of roads or bridle-paths. The main forest areas are two large blocks of deodar, blue-pine and fir—one on the Sutlej-Beas divide in the south-east of the state and adjoining Suket and Kulu Seraj ; the other north of the Beas on the high ranges immediately to the west of the Kulu valley and extending north-westwards to the Chota Banghal hills of Kangra. In the lower hills there are big but less valuable areas of *chil* pine, evergreen oak, and the mixed broad-leaf scrub which is such a feature of the eastern Punjab foothills wherever the natural cover has survived the ever-increasing pressure of over-population.



SPRUCE AND OAK FOREST AROUND BARMAKAS VILLAGE VERY HEAVILY LOPPED. THIS IS COMMON ALL THROUGH SERAJ AND NACHAN



UPPER LIMIT OF FIR FOREST IS DETERIORATING AND RETREATING DOWNHILL IN FACE OF HEAVY ALPINE GRAZING ALONG THE MADHOPUR RIDGE

23-FOOT GIRTH DEODAR IN KASHEHAL, SERAJ RANGE

FINE TALL DEODAR CROP IN PANDAR 2N ADJOINING BHUNKHAR AND THE SUKET BORDER

The Uhl river which supplies power for the Punjab's 140,000 horse-power electric plant, is a tributary of the Beas on the north bank. The water of the Uhl river is trapped at Brot and passed into a 3-mile tunnel through a spur of the Dhauladhar to emerge at Jogindernagar, where the headworks are situated. This great project met with much opposition and criticism in its early stages, particularly when delay and heavy expenditure had to be faced in the tunnelling operations, but it has already more than justified itself by the revenue and power development, for this project is one of the few bright spots in the current provincial budget.

During the construction stages this project gave much local employment but now actually provides very little. The only other industrial activities are in the salt mines at Drang and Guma which are worked as a state enterprise. The agriculture is very primitive. It is closely allied to the old-fashioned shifting cultivation of these hills and although further shifting has been checked since the introduction of a permanent settlement, the people have not yet learned how to conserve the soil of their fields except in a few of the rice-growing lands in the valley bottoms. Elsewhere the destruction of soil is so rapid that it becomes year by year more difficult to make a living from the average farm holding. Under the circumstances the forest resources and the employment which these provide assume a very great importance. The Mandi people were given an early chance of training in forest work through the activities during 1880-90 of a commercial concern, the Mandi Forest Co., which undertook deodar exploitation on a very large scale. The forests were depleted of most of their large trees, but in the process the local men received a training in sawing, slide-building and river transport which has, stood them in good stead, for their services are much in demand and there is a seasonal exodus of Mandi men into the neighbouring forest districts of Bashahr, Tehri Garhwal, Kulu and Kangra; these men return to their own homes each winter and forest work is the only means they have of earning cash to pay their taxes and land revenue assessment.

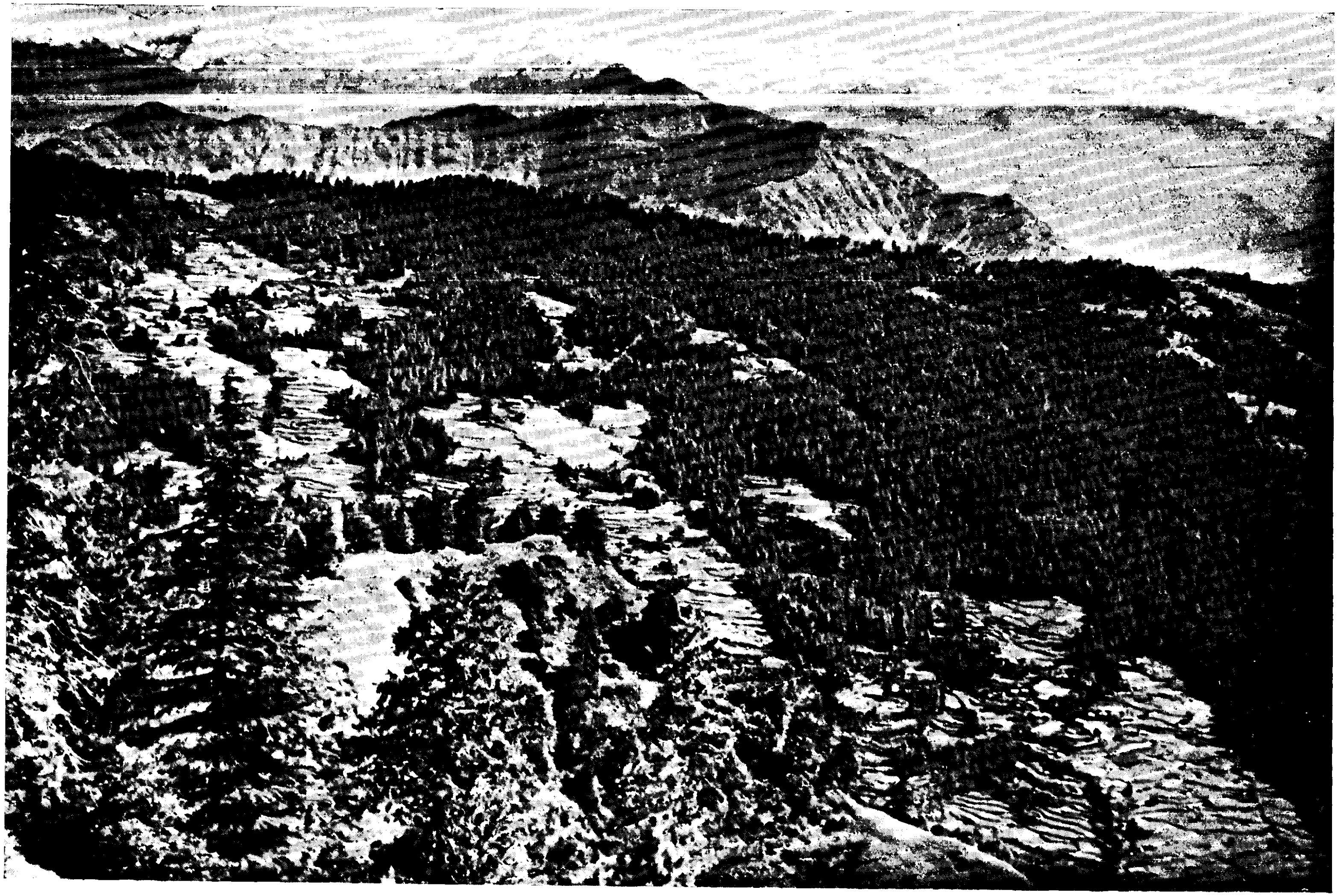
Forest conservation was introduced gradually but was not fully organised until 1915-17 when Mr. H. L. Wright, now Conservator of Forests, N.-W. F. P., was seconded to the state and drew up a forest settlement and a working plan. For some years following this the state was under a court of wards and various other Punjab officers looked after the forests. In 1925 the present Raja, His Highness Captain Sir Joginder Sen Bahadur, K.C.S.I., assumed charge and under his regime the careful and conservative forest management introduced by Wright has been fully maintained. The present Conservator, Kanwar Shiv Pal, is also Home Minister and has received his training at Aberystwyth and in Dehra Dun I. F. S. class. His forest staff consists of three Dehra Dun trained rangers and several deputy rangers and foresters who have been trained at the Punjab Forest School.

After nearly a year's work in Mandi I have come away fully impressed by the many good points in this state's administration. The British civil official used to depend very largely for his efficient administration of a district upon the personal touch, but this has, alas, been largely lost, submerged in a plethora of committees and office work, so that he can no longer maintain that close touch with the country-folks by direct contact and leisurely touring. Given a forceful personality and a desire for the good of his people, the ruler of an Indian state to-day still retains the advantages of a simple administrative machine and direct contact with his subjects. The advantages of this direct and simple method of government are clearly seen in Mandi.

EFFECT OF CURRENT FOREST MANAGEMENT ON FUTURE TIMBER SUPPLIES

The following is the substance of an address by Mr. H. G. Champion, Silviculturist, to the Forest Research Institute staff meeting on May 6th, 1936—

The usual history of the forests of a country is that they are subjected to a long period of maltreatment before their value is realised as a capital asset capable of valuable sustained production under



FORESTS OF PIUN BEAT, SHOWING INTIMATE MIXTURE OF FIELD AND FOREST

proper treatment. Where industry has been relatively advanced at the time of first settlement and opening up, the forests have been treated as mines and exploited regardless of their future. In such cases the extraction and utilisation sides of forestry have a monopoly whilst silviculture and management are ignored, the coniferous and hardwood forests of North America providing a striking illustration.

In India, though increase of population necessitating extension of cultivation and railway development resulted in further forest destruction in the middle of the last century, a large portion of the forests of most of the country had already been wiped out or rendered unproductive by long continued pressure of population on them, both human and animal. Forest reservation resulted in the protection of extensive tracts of more or less ruined forest and gradual regulation of the cut to what it was thought the forests could bear.

The following remarks will deal with the commercial exploitation of forests, leaving the local requirements of rightholders and others out of consideration as they only amount to about 1/20th of the total outturn.

The general method of working the forests at first was to estimate the number of existing timber sized trees, very usually those over six feet girth, and permit their removal at such a rate that with the estimated stock of medium sized trees and rates of growth, there would be about the same number again available when the fellings had worked through the forest and arrived back in the same coupe after 15 to 40 years. Practically nothing else was felled and the yield was obtained in the form of the biggest and oldest trees in the forest. The first fellings thus took most of the finest trees, but big unsound trees were usually left standing.

The next step was to prescribe *improvement fellings* to be combined with these *selection* fellings. Management had been introduced with the regulation of the number of trees to be felled and now silviculture was added with the improvement fellings which were supposed to be done more or less regardless of the financial return they might yield.

In areas of low quality or high demand for small materials, as common in the residual forests near towns, simple coppice or coppice with standards tended to be introduced in place of the selection with improvement.

Such selection fellings yield a relatively low yield per acre but a relatively high proportion of sound timber from large and often slow grown trees of high age whilst the improvement fellings when done—they were usually neglected—added a small proportion of smaller badly shaped trees and large unsound trees only partly fit for conversion.

It was very generally found that when the old coupes came under felling for the second and third time, and often in the later coupes of even the first cycle—the existing stock was not up to estimates and to keep up the yield the minimum size of exploitable tree had to be reduced : in any case, the big old trees of the more or less virgin forest had mostly gone.

About 20 years ago, for a variety of mainly silvicultural reasons, a changed outlook resulted in the adoption of more concentrated methods in various parts of the country, a movement the beginnings of which occurred locally much earlier but which now rapidly spread in all provinces and will undoubtedly greatly influence the future outturn of our forests.

Whereas the old selection method fellings covered the whole workable area in the relatively short period of 20 to 30 years taking practically only big trees and trusting largely to luck that young ones in all stages were in adequate numbers to replace them, the new methods select the areas in which mature stock most strongly predominates and remove all trees down to a much lower limit, or often actually clear-fell the whole stock. This happened first with chir-pine, then deodar, both with mainly natural regeneration, and has since been extended in all provinces to *sal*, teak and miscellaneous forest mainly with artificial regeneration.

The first effect of this change is concentration of working which reduces extraction costs and often justifies mechanical methods, roadways, tramways and skidders.

A further result has been the inclusion of a large amount of inferior material with the good. Trees of all sizes and of all qualities have to be disposed of or burnt *in situ* instead of only selected good large stems. Incidentally, this does not usually mean a large number of good poles of medium and small dimensions as much of the smaller material tends to be suppressed and crooked or of inferior species.

Again, all species have to be worked together whether present in small or large quantities, and much potentially useful timber for which there is no immediate demand, or only a demand at prices below extraction costs is inevitably wasted, being usually burnt on the spot, and on occasion (notably in the evergreen forests) has been brought out, converted, and sold at a loss or not at all. The apparent economic losses involved in this method have often been urged against it, but they are easily exaggerated and replacement of a mixed crop of low value by a plantation of valuable species can usually be justified.

Yields are everywhere more closely regulated to the growing stock than formerly, resulting in a reduction in the case of a good many advanced tracts (*sal* and deodar large timber), and the more accessible parts of the big blocks of wet tropical forest in South India and Assam. Any such reduction is, however, purely temporary in view of the immensely greater potential outturn of our forests as compared with present actuals.

Tending operations of all sorts have been extended very largely. At first these gave a relatively poor outturn of inferior material but in tracts which have been managed longest such as the United Provinces *sal* forests, they include thinnings in young and middle-aged crops yielding a large supply of poles of good quality.

The scale on which such concentrated work is proceeding is shown by the following figures for 1933-34, though these figures are not truly comparable as between provinces.

Area regenerated during the year including afforestation :—

Province	Mainly artificial Acres	Mainly natural, Acres	Total Acres
Bombay	28 942	58,783	87 725
Punjab	4,111	1,195	5,306
Madras	4 031	334	4,365
Bengal	2 413	..	2 413
United Provinces ..	1,727	5 829	7 556
Assam	1,367	765	2,132
Central Provinces ..	1,019	67,786	68,805
Bihar and Orissa ..	242	1 290	1 532

These figures shew that during the year 1933-34 45,000 acres of plantations were made in India (excluding Burma) and 1,36,000 acres were regenerated naturally. The total area of plantations corresponds to about ten times this annual figure or about $4\frac{1}{2}$ lakhs and only a very small proportion has yet come into bearing. The total area of young regeneration is difficult to give but is at least 15 times the current annual figure or, say, 2 million acres, our total reserved forest area being nearly 50 million acres.

At the moment there are signs of a check in plantation work due to shortage of funds and realisation that the work has often not been as carefully thought out as it should be. Siting and technique has still much progress to make, but it is quite evident that the check is only a temporary one, and work will be continued on an expanding scale except where improvements in methods of cheaper natural regeneration will result in a swing back in that direction.

The choice of species continues to exercise the minds of those responsible especially in miscellaneous forests. Nothing appears in the least likely to displace teak which for ease in raising and value when grown far surpasses all other possible starters. Similarly in chir-pine and deodar zones, there is little choice. In the *sal* tract, notably in Bengal, however, the question is an acute one. The general feeling supports the views expressed by the Economist at the 1934 Silvicultural Conference doubting the long-term prospects of heavy constructional timbers such as *sal*, and there is even a prescription in some Working Plans that not more than half the *sal* area shall be restocked with *sal*. The difficulty is to find a suitable alternative. Silviculturists have long realised the uselessness of small irregular supplies and the corresponding need of deciding on 1 or 2 good species and building up a good stock of them. Even when market requirements 40 to 80 years ahead have been predicted in this way, there are many cultural difficulties to be overcome, in fact Bengal has encountered disappointments with almost every species tried except *sal* itself leading to mutual recriminations between the silvicultural and utilisation experts.

This leads on to another point, the anxiety caused by alarmist reports of an extremely high relative incidence of beehole borer in teak plantation timber and of destruction of *champ* plantations by bug attack (*champ* being the best alternative to *sal* in Bengal) and the loss of plantations of other promising species from a variety of causes. These matters are still *sub judice*, but are not considered likely to alter the position very greatly. They have certainly intensified the doubts as to the wisdom of extensive pure plantations which exist on quite other grounds, and forced additional attention to the problems of closer assessment of site factors needed by different species and of mixtures.

Effects in the next quinquennium.—The only likely development is the availability in increasing quantity of poles of small and medium dimensions from thinnings of young regeneration and plantations of *sal*, teak, chir and deodar and an increasing pressure from management officers for the development of uses for these classes of material.

At present thinnings are done at direct cost and often left to rot, or burnt on the spot at further cost in the interest of fire-protection or sanitation ; or they are not done at all to the great detriment of the crops, postponement of their ultimate maturation and increased risks from all kinds of natural dangers.

At present we have a limited area of young crops already requiring thinning or shortly about to require it. Young chir-pine crops should yield about 300 six-inch poles per acre at 40 years of age and 90 eight-inch poles at 50. Plantations in Dehra grow far faster and will give these yields in half the time. Chakrata division has an annual coupe of 200 acres and West Almora division one of 600 ; the United Provinces alone has some 2,000 acres apart from large areas in the Punjab, Kashmir, Tehri and Nepal. Even halving these figures they remain large.

Well-stocked young *sal* crops of average quality should yield about 500 four-inch, 300 six-inch and 180 eight-inch poles at ages of 20, 30 and 40 years. The U. P. Gorakhpur plantations have not yet reached this age but many of our naturally regenerated areas have. Dehra Dun *sal* is inferior and these yields would be delayed about 10 years and be less than half as large (say, 300, 150 and 75). Bengal already has nearly 8,000 acres of *sal* plantation of high quality raised since 1916 and so now up to 20 years old. It is quicker growing than U. P. *sal* and requires thinning at 6 and 11, 16 and 26 years, yielding not less than 1,000, 400, 200 and 75 poles per acre of about 4″, 6″, 8″ and 10″ diameter, respectively.

Teak.—Though Burma has by far the greatest proportion of teak forest and plantations (over 100,000 acres), the Indian provinces already have several thousand acres of plantation. Teak grows rapidly and straight and thinnings are more urgent than in almost any other species. Plantations of good quality are thinned for the second time about the 12th year, yielding about 300 poles 4″—6″ diameter per acre : 5 or 6 years later a further 200 poles 6″—8″ and at a similar interval a further 100 poles 8″—10″ diameter. As with *sal*, sapwood predominates but shape and length are good.

The lack of demand for these thinnings has undoubtedly been largely due to their lack of durability rather than their strength or dimensions. It tends to be overlooked by enthusiasts that it costs almost as much per cubic foot to extract such poles as sawn heartwood and there is therefore a fairly high minimum depot sale figure below which Divisional Forest Officers cannot go. If considerable length is demanded, as it usually is in poles, extraction costs are further raised, but if the department sees only a bare margin over costs, it will welcome orders as solving the urgent thinning problem.

Effect in next decade or two.—The position as described for the next few years will remain much the same, but supplies of poles will steadily increase in quantity and upper size. At the same time supplies of big fully mature timber will continue to fall and an increasing proportion of the large timber will be more rapidly grown with wider rings and more sap being derived from thinned crops or crops under regeneration where management has aimed at concentrating as much as possible of the potential increment of a given area on selected good trees and at attaining marketable dimensions in a shorter time than hitherto.

In certain localities, notably Bengal, the increasing area of plantations of species such as *champ*, *panisaj*, *gamhari*, *jarul*, *tun*, *Cryptomeria*, alder and birch, will be offering poles and small timber in increasing quantity presenting the same problems as exist now for *sal* and teak. Many of these species grow much more rapidly than the hardwoods and are expected to yield sawn timber at 40 years.

Effect after several decades.—Supplies of large timber from over-mature stock will be exhausted in most places as already in several provinces and sawn timber will be obtained from forests which have been several decades under management. It will be from smaller trees which are cleaner grown and more uniform, but more quickly grown and with more sapwood. The total supplies will be very considerably increased especially for teak, *sal* and the conifers as there are few areas giving half the yield they might and the majority are only yielding a quarter or a tenth (Bengal *sal*) of what can

and probably will be obtained. This increased supply of hardwoods may be viewed with apprehension as far in excess of likely demands and a far-reaching change of policy may be forced on us before very long.

Poles will be available in ever-increasing quantity owing to the steady improvement in the general density of stocking of the forests and the execution of regular thinnings, especially with concentrated regeneration. If Gorakhpur continues its present rate of *sal* regeneration (350 acres per annum) giving full stocking on quality class III sites, in 40 years time its annual outturn may be put at 35,000 4″ poles, 20,000 6″, 10,000 8″ and 50,000 10″. It may be noted that the intensively worked but poor forests of the division are at present yielding about 8 c.ft. per acre per annum, roughly one-quarter their potential figure. Similarly in the three Duars *sal* divisions of Bengal at the present rate of *taungya* plantation, if 2/3 on *sal* ground is new *sal*, there will be about 30,000 acres of *sal*, the yield from thinnings from which would be—

3,60,000	poles of	4″	diameter
72,000	,,	6″	,,
36,000	,,	9″	,,
18,000	,,	12″	,,

The problem will be what to do with them all.

For naturally regenerated chir-pine in the U. P. with serious fire risks, it is more difficult to estimate than for uniformly stocked plantations, but in one of at least a dozen felling series accessible to floating streams, the annual outturn might be put at 50,000 poles of 6″ diameter, 16,000 poles 8″—10″ diameter and 6,000 of 12″—14″, whilst the sawn outturn should ultimately rise to about 125,000 sleepers in place of the present 8,800.

Again 1,000 acres of good teak plantation, planted at a rate of 20 acres per annum—Bengal is now planting 100 and Madras about 700 acres—should be yielding annually in 50 years' time some 6,000 small poles under 6″ diameter, 6,000 from 6″—10,″ 1,000 from 10″—14″ and 200 over 14″, the older plantations of Nilambur and Travancore proving that this is no flight of fancy.

What we shall have in the way of good softwoods depends partly on progress of silvicultural knowledge but above all on the decisions reached in the near future as to what should be planted. So far the tendency has been first to grow the important local species, usually *sal* or teak, and then to play in a rather dilettante way with other softwood and hardwood species. The silviculturist is always feeling the need of a clearer lead from the utilisation side of forestry in this matter. It is one of his duties to see that the protective value of the forests is properly considered, but once that is cared for, his chief duty is to raise timbers of the species, quality and sizes for which the utilisation experts feel most confident in predicting a market, and to produce them in the most economic way compatible with sound silviculture. Hazardous as such predictions must be, the utilisation expert has more facts to go on than the silviculturist who is stepping out of his province if he attempts these predictions himself. The obvious course is to concentrate on an increased outturn of unquestionably good general purposes timbers suitable for boxwood, plywood, veneers and light construction, but there are as yet few signs of any definite policy in this direction. The problem is a serious one and needs facing soon as the results of a mistake now will be heavily paid for later on.

DISCUSSION ON MR. CHAMPION'S ADDRESS

Captain Trotter said that the present-day tendency was towards an increased utilisation of softwoods rather than of hardwoods and it was rather unfortunate that India was comparatively poor in suitable softwoods. Conifers were fairly abundant in India but they were found in inaccessible places and their exploitation was not only difficult but most expensive. In England, for instance, over 90% of the timber used was softwood. He said that at present there appeared to be three large lines of prospective timber development in India, namely, plywood, the treatment of timber with preservatives, and paper pulp. At present over 32,000 tons of plywood and 8,000,000 plywood boxes were being imported yearly in India

which indicated a great scope for development in this line alone. He continued as follows—

"The second line I mentioned was the treatment of timber with preservatives. You all know that treated wood lasts a long time. Mr. Champion has raised the question of utilizing the poles which will be available in increasing number every year. Now poles consist of a large proportion of sapwood which is useless so far as durability is concerned unless it is treated, and we therefore require some preservative to make it durable. You have probably all heard of Mr. Kamesam's wood preservative known as ASCU which up till now appears to be a superior preservative for the treatment of timber and especially for preserving and thereby furthering the utilization of poles."

He then referred to the Timber Development Section which has recently been started at the Forest Research Institute. One of the functions of this Section is to find ways and means by which timbers could be used more extensively than at present and Captain Trotter hoped that the activities of this Section will lead to increasing markets for poles, etc., which cannot be sold at present.

"We then have the third big line, namely paper pulp. We know that in big countries like Canada and Russia, where there are soft-woods, very large quantities of these woods are used for mechanical pulp for making paper. We have started experiments here to see whether we can do anything in the way of making mechanical pulp from bamboos and also from other woods. If success is attained it will be a big step forward towards the more extensive use of our forest products."

Mr. Bhargava said that he understood from Mr. Champion's lecture that in certain provinces species of timbers were grown without any idea as to whether there would be a demand for them in future. He suggested that experiments should be started in these provinces to find out the possibility of growing woods suitable for making mechanical pulp, as there existed in the country a definitely large and growing demand for such woods. India consumed every year 100 thousand tons of paper made from mechanical pulp and the demand for papers of this quality was growing steadily. If

suitable woods were available locally there would be no necessity of importing such a large quantity of paper from outside. Experiments are shortly going to be started at the F. R. I. as soon as the grinder which is on order is received in order to find out what species would be suitable for the production of mechanical pulp.

Mr. Champion replied that Bengal was experimenting with certain species in their *sal* plantations and if Mr. Bhargava would suggest what particular species would find a sure market for the production of mechanical pulp he had no doubt that the plantations of such species would be taken up eagerly.

Mr. Limaye enquired whether substitutes for certain imported species like beech, ash, hickory and boxwood could be grown in plantations in India. In view of the existence of a large number of cotton and jute mills in India there is a considerable demand for woods suitable for making special articles such as picker arms, shuttles and bobbins, etc. Several enquiries are received for advice about Indian substitutes for making these articles most of which are now either imported or made from imported wood. Mr. Limaye had found *Sageraea listeri*, *Gardenia* sp. and *Murraya exotica* as good substitutes for boxwood and advocated raising them artificially.

Mr. Champion replied that extraction of natural boxwood from Bashahr Division had not been a success. "We have, as you are all aware, also tried *Gardenia* and I think it would be better to grow it as a secondary species in plantations as there is a strong feeling against growing pure plantations and everybody is now thinking of growing mixtures."

Dr. S. V. Puntambekar enquired whether there were any other seasoning kilns in India besides those at the F. R. I. for seasoning timbers locally.

Captain Trotter: "We have designed a furnace kiln which can be installed at a comparatively small cost. This type of kiln will, we hope, be popular with the smaller cabinet and furniture makers. There are several kiln installations in India such as those recently installed by Messrs. Mansfield and Sons and Messrs. The Gramophone Company, Calcutta. It is reported that these kilns are working satisfactorily. It is hoped to instal a couple of kilns of the same design in the Punjab shortly."

THINNING INTENSITY

BY K. P. SAGREIYA, I.F.S.

The writer is very glad to see that the subject of "Gradation in Thinnings" is under discussion. The subject is of special interest to the Central Provinces at the present time as they have large areas of teak and *sal* forests of varying ages up to 8 years and they want to determine the optimum thinning regime and then to formulate simple instructions to guide the subordinates.

With this end in view the writer recently laid out an Experimental Plot in a naturally regenerated teak forest, 8 years old (C. P. III Q. Average height of dominant trees at maturity 50′—70′), on the following lines, and he would welcome any helpful comments on his suggested classification :—

All stems up to 0·5″ d. b. h. were cut back in cleanings when thorns and climbers were also removed. The remaining stems were classified into height-cum-development quality classes as below :—

At least $\frac{3}{4}$ of the average height of dominant trees at the time of thinning and with major portion of the crown including the leader quite free—

Normal crown and good stem—DOMINANT, GOOD (D).

Defective crown or stem—DOMINANT, BAD (D′).

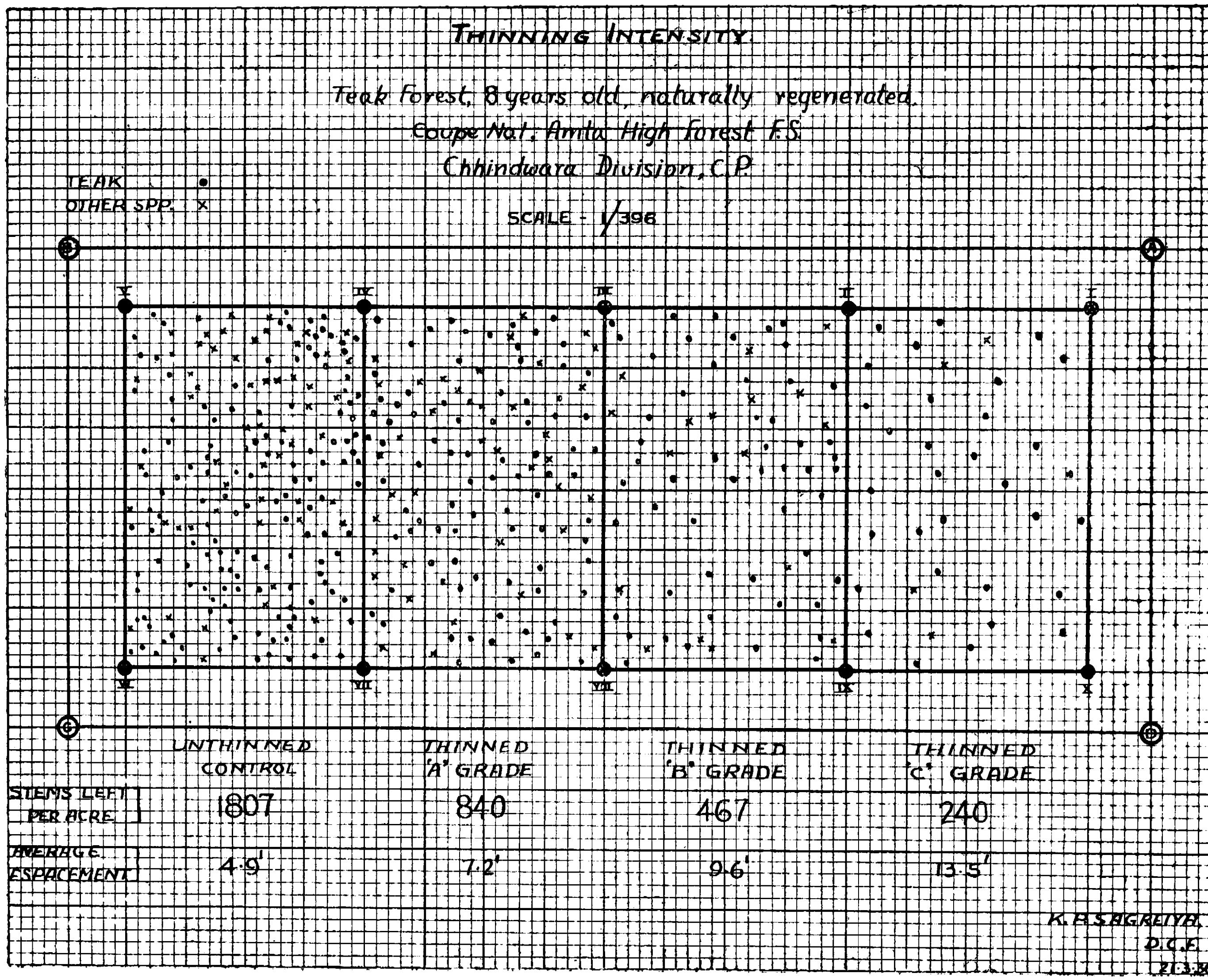
At least $^3/_5$ of the average height of dominant trees at the time of thinning. Major portion of the crown may be overtopped but the leader must still be more or less free—

Normal crown and good stem—DOMINATED, GOOD (d).

Defective crown or stem—DOMINATED, BAD (d′).

At least $^3/_5$ of the average height of dominant trees at the time of thinning. The entire crown or at any rate the leader completely overtopped—SUPPRESSED (s).

Diseased, malshapen, dead, weak or otherwise unfit for retention —MORIBUND (m).


THINNING INTENSITY.
Teak Forest, 8 years old, naturally regenerated.
Coupe No1. Amla High Forest F.S.
Chhindwara Division, C.P.
TEAK •
OTHER SPP. x
SCALE - 1/396
UNTHINNED CONTROL
THINNED 'A' GRADE
THINNED 'B' GRADE
THINNED 'C' GRADE
STEMS LEFT PER ACRE
1807
840
467
240
AVERAGE ESPACEMENT
4·9'
7·2'
9·6'
13·5'
K. P. SAGREIYA.
D.C.F.
21·3·36

Based on this classification a mechanical thinning was carried out as under—

THINNING INTENSITY		STEMS REMOVED.	STEMS RETAINED.
"A" Grade (Light)	..	m, s	d′, d, D′, D
"B" Grade (Medium)	..	m, s, d′	d, D′, D
"C" Grade (Heavy)	..	m, s, d′, D′	d, D

Subject to the following exceptions—

(*i*) A stem falling into the "retained" category was felled if standing too near a better stem;

(*ii*) A stem falling into the "removed" category was left standing when its removal would have created too big a gap.

These operations resulted in almost uniformly spaced stems in the three sub-plots as will be seen from the plot chart, given in Fig. 1. Other statistical details are as under, each sub-plot is 1·0×1·5 chains rectangle—

No. of stems before thinning.

	By diameter class					By crown class						Total.
	1″	2″	3″	4″	5″& over	D	D′	d	d′	s	m	
Unthinned (control) ..	117	103	40	10	1	32	23	43	67	58	48	271
Thinned "A" Grade ..	119	116	40	4	2	43	15	48	38	86	51	281
Thinned "B" Grade ..	91	102	38	3	..	31	22	21	45	86	29	234
Thinned "C" Grade ..	111	81	37	14	4	26	15	14	23	133	36	247

No. of stems after thinning.

Unthinned (control) ..	117	103	40	10	1	32	23	43	67	58	48	271
Thinned "A" Grade ..	29	64	28	3	2	40	14	40	32	..	..	126
Thinned "B" Grade ..	6	39	22	3	..	31	21	18	..	..	..	70
Thinned "C" Grade ..	..	4	15	13	4	26	4	6	..	..	..	36

The number of stems left per acre and the average espacement under the various grades were as under :—

	Stems per acre	Espacement $\left(\sqrt{\frac{A}{N}}\right)$
Unthinned ..	1,807	4·9′
"A" Grade ..	840	7·2′
"B" Grade ..	467	9·6′
"C" Grade ..	240	13·5′

PRIZE DAY AT THE BURMA FOREST SCHOOL, PYINMANA.

The annual prize distribution at the Burma Forest School took place on April 27, 1936, before a large gathering in the Main Hall. The following officers were on the platform with the Director (Mr. G. D. Warwick), the Chief Conservator of Forests (Mr. H. R. Blanford, O.B.E.), the Director of Public Instruction (Mr. P. B. Quinlan), the Conservator, Sittang Circle (Mr. E. W. Carroll), the Conservator, Chindwin Circle (Mr. H. C. Smith), the Deputy Commissioner of Yamethin District (Lt.-Col. H. H. Batten, I.A.), the Divisional Forest Officer, Thayetmyo Division (Mr. H. E. Flint), and the Divisional Forest Officer, Yaw Division (Mr. A. F. R. Brown).

The Director opened the proceedings with an address in the course of which he drew attention to the fact that the School had been in existence for 38 years, but had inhabited the present buildings since 1910 only, and had trained 702 forest officers at Pyinmana.

The Director commented briefly on the year's work, a full report on which had already been considered by the Board of Control. He emphasised the fact that the greater part of the year had been spent in the forest in practical training during which a considerable amount of useful work had been done for the local division. Discipline and health had been good and the "sports" side of the training had not been neglected though the presence of depleted numbers at the School had prevented the School teams from distinguishing themselves.

Twenty-one students completed the course of whom 18 obtained certificates.

After presenting the certificates and medals the Chief Conservator of Forests expressed his satisfaction with the progress made at the School, especially in the direction of physical and disciplinary training. He drew attention to the effect of the heavy retrenchments of the past few years resulting in the stagnation of promotion and the impossibility of justifying the revival of the English Class for direct appointment to the Ranger cadre without first restoring the correct proportion of promoted men to direct recruits. He stated that the class passing out was the fourth to take the reduced course of 19 months and expressed his satisfaction that the Ministry of Forests had approved of the full two years' course being started again in May, 1937.

He then addressed the students as to their future conduct after leaving the School and asked them to assist in educating the public among whom they would live in the principles of Forestry. He advised the students to continue their studies in the forests and trusted they would do nothing in their future work and behaviour to diminish the high standards of their profession.

The Director of Public Instruction followed with further advice and encouragement. He suggested that students should become pioneers of village uplift by teaching the villagers the elements of hygiene and sanitation and reiterated his advice given last year regarding the cultivation of a hobby.

At the close of the proceedings the visitors inspected some of the work of the students and also went over the Museum. Refreshments were served in one of the lecture rooms.

Later in the day a Pagal Gymkhana was held on the School Recreation Ground where the staff were "At Home" to their guests.

JUDGMENT OF THE HIGH COURT OF JUDICATURE AT ALLAHABAD IN THE APPEAL OF THE B. B. & C. I. RY. *versus* B. DWARKA NATH.

We publish in full the judgment of the Hon'ble the Chief Justice and the Hon'ble Mr. Justice Bennet of the High Court of Allahabad in the appeal of the B. B. & C. I. Railway *versus* B. Dwarka Nath, as it is of considerable interest to Forest Officers. From a perusal of these judgments it appears that the Railway have a statutory right to run locomotives on their permanent way and are under no legal liability to clear the grass from their track. In all cases of such actions against Railway Companies for damage done by fire it is necessary for the plaintiff to prove negligence, *i.e.*, that proper steps were not taken to prevent the emission of sparks from the funnel of the engine. The absence of a proper spark-arrester may be interpreted as negligence. In the present case B. Dwarka Nath was found guilty of contributory negligence in the way he cut his grass and because he took no precautions such as cutting a fire-line to prevent a fire starting on Railway premises crossing on to his own. Had Dwarka Nath adopted all such possible precautions he would still have had to prove negligence on the part of the Railway Company and failure to cut the grass on the line was held not to amount to negligence on their part. Forest Officers should, therefore, remember that the Railway is liable for forest fires only if negligence can be proved against them, but that if negligence can be proved and no contributory negligence arises on the part of the forest owner they are fully liable for fires caused by their trains.

C. G. T.

HIGH COURT OF JUDICATURE AT ALLAHABAD

CIVIL SIDE, APPELLATE JURISDICTION, DATED ALLAHABAD, THE 13TH DECEMBER 1935.

Present:

The Hon'ble Sir Shah Mohammad Sulaiman, KT., Chief Justice,

and

The Hon'ble E. Bennet, Judge.

L. P. A. No. 33 of 1935.

L. P. A. against the decree of Mr. Justice Bajpai, Judge of this Hon'ble Court, dated the 23rd January 1935, under Section X of L. P. A. Act in S. A. No. 1199 of '32.

B. B. & C. I. Railway .. Defendant—Appellant

versus

B. Dwarka Nath .. Plaintiff—Respondent.

BY THE HON'BLE THE CHIEF JUSTICE

I agree that the appeal should be allowed and the plaintiff's suit dismissed. There are two questions which arise in this case. The first is whether the Railway Company by not having taken sufficient precautions to prevent damage has been guilty of such negligence as to make it liable for the loss sustained by the plaintiff. The second is whether even if the Company had been guilty of negligence the plaintiff also has not contributed by his own default to the same negligence which resulted in the loss occasioned to his property. The first question is not free from difficulty. The case put forward by the plaintiff simply was that the grass within the railway fencing was set fire to when the defendant's engine passed that way and it was alleged in the alternative that either the fire originated from live sparks escaping from the engine or from live cinders falling down from the ash-pan of the engine, with the result that the dry grass within the Railway fencing caught fire first and then spread to the grass outside the fencing which belonged to the plaintiff and ultimately reached the place where the plaintiff's hay-stacks were located. The first court came to the conclusion that when the engine was running at speed it was quite possible that live cinders might drop down from

the ash-pan on the railway bank and it held that there was grass on the railway banks which caught fire owing to live cinders falling down from the railway engine which fire spread on to the plaintiff's land and burnt the plaintiff's *patel* and trees. The lower appellate Court, while affirming that the finding was not so definite, came to the conclusion that there was grass on the defendant's land between the fencings on the two sides of the railway line about one cubic and a half high and that the grass caught fire owing to sparks falling down from the railway engine and that the fire spread on to the plaintiff's land and burnt his *patel* and trees. Both the courts below recorded a finding that the Railway Company should have taken reasonable care and caution but that it did nothing of the sort and that negligence on the part of the defendant was established in the case. A learned Judge of this Court has accepted this finding. On the question of contributory negligence also the finding was in favour of the plaintiff.

Now the question of the liability of a railway company for taking every reasonable precaution to prevent damage to owners of neighbouring lands has created a conflict of opinion even in England. In Piggot *versus* Eastern Counties R. Co. 3 C. B. R. 229 (1846) it was laid down that the fact of certain premises being fired by sparks emitted from a passing engine was *prima facie* evidence of negligence on the part of the company rendering it incumbent on them to show that some precautions had been adopted by them reasonably calculated to prevent such accidents. In Smith *versus* The London and South-Western Railway Company Common Law Series C. P., Vol. VI, p. 14, certain workmen employed by the Railway Company, after cutting the grass and trimming the hedges bordering the railway, placed the trimmings in heaps between the hedge and the line and allowed them to remain there for some days during very hot weather; a fire broke out between the hedge and the rails and burnt some of the heaps of the trimmings and hedge and spread to a stubble field beyond, and was thence carried by a high wind across the stubble field and over a road and burnt the plaintiff's cottage which was some 200 yards away from the place where the fire broke out. There was no definite evidence that it had been due to any spark

from the engine which had passed shortly before the time. The court held that it could be fairly presumed that as engines while passing do emit sparks, the fire originated from the engine that had just passed and that there was sufficient evidence for the jury to return the verdict that the defendants were negligible in leaving the dry trimmings and that the trimmings either originated or increased the fire and caused it to spread to the stubble field and that if the defendants were negligible they were responsible for the injury that resulted.

In Rev. *versus* Pease, 4 B. and Ad. 30, it was held that if a statute authorised the construction of a railway parallel to an ancient highway and if by the passage of waggons, horses of the plaintiff were startled, there could be no indictment for a nuisance inasmuch as the interference with such rights of the public must be taken to have been contemplated and sanctioned by the Legislature.

In Vaughan *versus* Taff Vale Railway Company, 5 H. and N. 679, it was laid down that where a wood belonging to the plaintiff had been set on fire by sparks from a locomotive authorised by statute and it was shown that sufficient precaution had been taken by the Company, there was no liability. Cockburn, C. J., remarked : "When the Legislature has sanctioned and authorised the use of a particular thing and it is used for the purpose for which it was authorised and every precaution has been observed to prevent injury the sanction of the Legislature carries with it this consequence that if damage results from the use of such thing independently of negligence the party using it is not responsible." The case therefore was an authority for the proposition that unless negligence was established independently the mere use of an authorised thing would not entitle a plaintiff to claim damages when every precaution had been observed to prevent injury. On the other hand in Jones *versus* Festiniog Railway Company, L. R. 3. Q. B. 733, a company had been empowered by Act of Parliament to make and use a railway for the passage of waggons and engines and ran passenger trains drawn by locomotive steam engines and had "taken all reasonable precautions to prevent the emission of sparks." The plaintiff's hay-stack was, however,

fired by sparks from one of the engines. Blackburn and Lush, J.J., held that as the Company had no express powers given them by statute to use locomotive steam engines they were liable at common law for the damage though negligence was negatived. In that case the plaintiff had failed to prove that there was a clear negligence on the part of the Company. Nevertheless the Bench held the Company liable under the common law. The position was re-examined by the House of Lords in Hammersmith Railway Company *versus* Brand, L. R. 4. H. L. 171, which was, however, a case of damage caused to the plaintiff's land by the vibration caused by trains passing on the railway track.

Bramwell, B., expressed the view that the cases of Pease and Vaughan were wrongly decided. But the opinion of the majority of their Lordships was to the effect that those cases were rightly decided and it was held that "It was established by those cases that when the Legislature has sanctioned the use of a locomotive engine there is no liability for any injury caused by using it so long as every precaution is taken consistent with its use."

Later in Powell *versus* Fall, 5 Q. B. D. 597 the defendant Company was possessed of a traction engine which was propelled by steam power. Whilst it was being driven by the defendant's servants along a highway some sparks escaping from it set fire to a stack of hay of the plaintiffs standing on a neighbouring farm. The engine had been constructed in strict conformity with the locomotive Acts and at the time of the accident it was being driven at a proper pace and the defendant's servants had not been guilty of any negligence whatsoever in its management; nevertheless Mellor, H., whose judgment was upheld by Bramwell, L.J., and in appeal held that the defendant was liable to compensate the plaintiffs for the injury done to the stack upon the ground that the engine being a dangerous machine an action was maintainable at common law. The case of a Canadian Pacific Railway *versus* Roy has been distinguished by my learned brother. I may only quote a passage from the judgment of the Lord Chancellor at 231: "The Law of England equally with law of the province in question affirms the maxim 'six uters tuo ut alienum non

laedas' but the previous state of the law, whether in Quebec or France or England, cannot render inoperative the positive enactment of a statute and the whole case turns not upon what was the Company law of either country, but what is the true construction of plain words authorising the doing of the very thing complained of." Their Lordships then proceeded to consider the effect of the provisions in the Dominion Railway Act. The question has been, however, settled in England by the enactment of the Railway Fires Act under which Railway Companies are now made liable to a limited extent even without any proof of negligence at all.

In India the leading case on this subject is that of Halford *versus* The East Indian Railway Company (14 Bengal Law Reports, p. 1). The Bench in affirming the judgment of the learned single Judge made it perfectly clear that there was a certain amount of liability on a Railway Company not only for keeping a properly constructed engine but also for keeping the railway track in a proper state. At p. 17 it was stated " But the Company are bound not only to use due care in the construction and use of their engines but also to use due care in keeping the line of railway and the land belonging to them on each side of it in a proper state." The authority for this proposition was Smith's case where the Railway Company had been made liable not on account of any defect in the construction of the engine or of not adopting means to prevent the emission of sparks or the falling of live cinders from the ash-pan, but because the servants of the Company had allowed dry grass to be on the land of the Company on each side of the railway in what was alleged to be a negligent manner and thereby the fire was caused which burnt the plaintiff's cottage. Again at p. 18 it was remarked " now in considering whether there was due care in keeping the land of the Company on each side of the railway in a proper state we must keep in mind (as is said by Bovill, C. J.) that if the Company are using an engine which emits sparks and causes a risk of fire it is incumbent on them, although they may be entitled to use it, to keep the line of railway in a proper state with reference to such danger." The evidence in the case was then examined and the case was decided on the finding that the

evidence was not sufficient to show that the grass was left in the state as described by the paintiff's witnesses or in a state other than that what a witness for the defendant had said might fairly and reasonably be left. The Bench, therefore, after considering the whole evidence came to the conclusion that the view taken by the learned single Judge was not wrong. I do not take that case to be an authority for the proposition that the Railway Company's liability ceases as soon as it is shown that there was no defect in the contrivance of the engine much less that there is no liability unless the plaintiff establishes that there was a defect in any such contrivance. Even the English cases have laid down that where damage has been caused by sparks emitting from a railway engine it is incumbent on the Company to show that there was no defect in the contrivance which might have allowed sparks to escape. No doubt in India we have the Railway Act and under section 13 of that Act the Governor-General in Council is authorised to require certain precautions to be taken. But I do not take the enumeration of the precautions mentioned in section 13 as in any way exhaustive, for instance defects in the contrivance of an engine are not mentioned therein and it cannot be on the authorities urged that such a defect would not make the Railway Company liable. I also think that it is not possible to give a complete catalogue of all sorts of precautions which must be taken by a Railway Company to ensure that no damage is done to owners of neighbouring lands. Each case must depend on its own circumstances and the Court has to decide on the evidence before it whether there has been negligence to such an extent as to make the Company liable.

There is obviously no statutory duty on a Railway Company to cut all grass from the railway track and to see that at no place any grass grows or that any dry grass is allowed to remain there. At the same time this may be a reasonable precaution which a Railway Company should take as indeed the B. B. & C. I. Railway Company have already issued standing orders under which there is a direction that grass should be removed from the railway track. The authority given to a Railway Company is not merely to run trains and use engines, but to use the whole railway line for purposes of traffic. Their duty is

accordingly not confined to trains and engines only. So far as damage caused by sparks emitted from the funnel of an engine is concerned proof of negligence would depend on the defective nature of the contrivance used to prevent the emission of sparks. So far as fire caused to dry grass growing on or near the railway track is concerned the damage may be caused by the ignition of such grass by live cinders falling from the engine. It is for the Court to decide whether dry grass has been allowed to remain on the railway track so close to the rails and so high in stature as to amount to negligence on the part of the Railway Company. It would be impossible to answer this question in the abstract independently of the facts of each case. In this view of the matter I would feel very reluctant to hold that there was no legal evidence whatsoever before the courts below to arrive at the finding that negligence had been established. Negligence is at least a mixed question of law and fact and unless it is shown that the Court has approached the question from a wrong standpoint or that the evidence is such that there was no option but to draw the converse conclusion or unless the finding is vitiated by some other legal defect it may be difficult to upset such a finding in second appeal. I would, therefore, base my decision on the second point.

The question of contributory negligence had been raised by the defendant in both the courts below, though the finding was against the defendant. As has been pointed out by my learned brother the utmost that can be said against the Railway Company is that they were guilty of nonfeasance in not removing dry grass from the railway track when it had grown high. It has to be conceded on behalf of the plaintiff that the plaintiff was guilty of the same omission in not removing dry grass from the vicinity of the railway line. Furthermore the plaintiff lives on the spot and was aware of the danger and could not but have known that sparks or cinders might come out setting fire to the grass within the railway fencing which would then spread to the dry grass on his own land next to the railway fencing from which it might spread on to the hay-stacks which he had put up. He took no precaution either of cutting off his grass farm from the railway fencing or even protecting his hay-stacks by making any fire-

line. The Railway Company has to maintain hundreds of miles of rail-roads and the chance of their becoming aware that grass has grown high at a particular spot is far more remote than the definite knowledge which the plaintiff must have possessed that the grass on that part of the railway track was high and so was the grass on his own land adjacent to the railway fencing. It seems to me that the damage which has been caused to the plaintiff was not caused so much by the fire being set to the grass on the railway track as by the circumstance that it spread on to the plaintiff's own grass farm and then reached his hay-stacks. If the plaintiff had taken sufficient precaution to maintain a fire-line or even if he had cut the grass from the vicinity of the railway fencing first, no damage would have been caused to him at all. I would, therefore, allow the appeal and dismiss the plaintiff's claim on the ground that he was guilty of contributory negligence of which he was fully cognisant and that is a good defence in law which must prevail.

13-12-1935. (Sd.) S.M.S.

BY THE HON'BLE MR. JUSTICE BENNET.

This is a Letters Patent Appeal brought by the defendant the B. B. & C. I. Railway Company against the judgment of a learned single Judge of this Court dismissing its appeal. The two lower courts have granted a decree against the defendant awarding the plaintiff Rs. 600 damages under the following circumstances :—

The plaintiff brought a suit alleging that his land, consisting of waste and jungle lands with *patel* grass growing on it and timber and fruit trees, adjoins the railway and that in the month of April 1930 the *patel* grass had been partly cut and stored in heaps and part was standing, that on the 13th April 1930 the passenger train of the defendant Company passed along the line and sparks of fire escaped from the engine and dropped on to the railway *patri* just close to the rails. Paragraphs 5 and 6 of the plaint are as follows—

"That the *patri* was not clear but covered with grass which had not been removed owing to the utter negligence and carelessness of the servants of the defendant and therefore the grass on the *patri*

immediately caught fire and from there the fire at once spread over the plaintiff's jungle lands burning the standing *patel* and its heaps along with some 16 *nim* and *shisham* trees worth Rs. 700, all belonging to the plaintiff."

"That it was the duty of the defendant Company to keep the *patri* quite clear and free from any grass and other combustible substance and to take full precautions to prevent the setting up of fire to the adjoining jungle lands of the plaintiff which it failed to do."

These were the only paragraphs in the plaint alleging negligence and it is to be noted that the only negligence alleged was the negligence of the Railway Company in not keeping the *patri* quite clear and free from grass, etc. The defence of the Railway Company was to put the plaintiff to proof of the fact that the fire had been caused as he alleged and further the Railway Company pleaded in paragraphs 13 and 14 of the additional pleas as follows : "That the defendant Company will rely on the principle *lex non cogit ad impossibilie* (the law does not compel a man to do that which he cannot possibly perform) as affording a complete answer to the plaintiff's claim." The defendant Company maintains that the fire, if any, was due to the negligence of the plaintiff in keeping the grass in the state alleged in paragraph 3 of the plaint near the railway track, whereon to the knowledge of the plaintiff locomotive steam engines of the defendant Railway Company were authorised by statute to pass and re-pass day and night.

This pleading was further amplified by a statement of the advocate for defence on the 8th June 1931 part of which was as follows : "The plaintiff should himself take care of the grass on his land. If he did not take care there was contributory negligence on his part." The only issue framed on negligence was issue No. 5 "whether there was any negligence on the part of the defendant in not removing the grass, if any, and in not keeping the land between the fire-lines clear." The finding of facts as to the cause of the fire in the trial Court was : "I hold that there was grass on the railway banks which caught fire owing to live cinders falling down from the railway engine which fire spread on to the plaintiff's land and burnt the *patel* and the trees." The Court also stated that on the plaintiff's

evidence the fire originated in live sparks escaping from the engine and in live cinders falling down from the ash-pan of the engine. The Court inspected the engine but did not find that there was anything defective in the type or working of the engine and no such defect was alleged. The trial Court found that there were 12 stacks of *patel* grass burnt valued at Rs. 420 and standing *patel* grass burnt which was valued at Rs. 100 and certain trees burnt valued at Rs. 80 and, therefore, the total amount of compensation awarded was Rs. 600. The trial Court also found : " It is the duty of the defendant to keep the fire-line clear of grass, etc., specially during the hot season when the grass becomes dried up." It also found that no case of contributory negligence was proved against the defendant on issue No. 9 as it held that there was no evidence to show that the arrangement made by the plaintiff for disposing of the *patel* was such as to amount to negligence on his part. The defendant Company appealed and the lower appellate court came to practically the same findings as follows—

"I therefore accepting the plaintiff's evidence hold that there was grass on the defendant's land between the fencing on either side of the railway line 1 to 1½ cubit high ; that that grass caught fire owing to sparks falling down from the railway engine and that fire spread on to the plaintiff's land and burnt his *patel* and trees." Further it was found : " It was the duty of the Railway Company to keep the fire-lines clear of grass especially during the hot season when the grass becomes dried up " and that " it might be inferred " from the statement of a railway official that " from 1927 the plaintiff was claiming compensation for damages caused to his jungle by the sparks of the defendant Company's engines. The Railway Company should have taken reasonable care and caution, but it did nothing of the sort rather it allowed the grass to remain on the banks of the railway line. Under the circumstances it can be reasonably inferred that there was negligence on the part of the defendants." On the question of contributory negligence the Court found as regards the plaintiff's grass : " The heaps of *patel* were lying at a sufficient distance from the railway fencing. No doubt the standing *patel* extended up to the railway fencing, but it cannot be said that there

was any contributory negligence on the part of the plaintiff." Now as regards the reference in this finding to the fire-lines this appears to be based on some instructions given by the Railway Company that fire-lines should be cut in the grass on the *patris*. The lower appellate court is not quite clear whether it considered that the duty of the Railway Company was to keep these fire-lines cut or to cut the whole of the *patris*. The learned single Judge of this Court refers to a few rulings on the subject and considers that the Railway Company had the duty alleged and were guilty of an actionable negligence. The only point of contributory negligence argued before the learned single Judge was that the servants of the plaintiff did not take steps to put out the fire when they saw it begin. The grounds of contributory negligence which had been argued before the lower appellate court do not appear to have been argued before him, that is, in regard to the arrangement of the plaintiff for the cutting of the crop. Now when the case came in the Letters Patent Appeal the first ground taken was that the suit brought was not maintainable and that the Railway Company was not legally liable for the damage because there was no actionable negligence on the part of the Railway Company and that the mere existence of growing grass about a foot and a half high within the railway fencing was legally no evidence of negligence at all. Further it was argued in ground No. 5 that by allowing the grass on his own land to grow high right up to the railway fencing the plaintiff had been guilty of negligence and was not entitled to the relief claimed. There are, therefore, two points of law in this appeal: firstly, whether there was a duty of the Railway Company to cut the grass within their fencing and, secondly, whether the plaintiff was guilty of contributory negligence. Now the railways in this country are run under the authority of Act IX of 1890 of the Railway Act. That Act provides certain precautions in different sections and particularly in section 13 it is laid down that the Governor-General in Council may require that within a time to be specified in the requisition or within such further time as he may appoint in this behalf certain precautions shall be taken by a Railway Company. These precautions include the fencing and a

screen adjoining the side of public roads to prevent horses and other animals being frightened and suitable gates, chains, bars, stiles or hand-rails to be erected or renewed at crossings and persons to be employed by the railway administration to open and shut these gates, chains or bars. Now if the Legislature had intended that a Railway Company should have the duty of cutting the grass within its fencing, it appears that section 13 would have made a provision for the Governor-General in Council to issue orders on the subject. The length of the line of a company like the defendant Company is often very considerable and extending to thousands of miles. The cutting of grass within that area, if it is a duty of a railway company, is a very considerable matter and one which would entail a very large amount of expenditure. It is, therefore, a matter which would certainly attract the attention of the Legislature in passing an Act like the Railway Act and it is strange that if such a duty were to exist on a railway company in India there would be no provision in the Railway Act of 1890 for the framing of rules on the subject. It is true that in the present case it is shown that the Railway Company itself issues some instructions in regard to the cutting of grass, but the fact that the Company does issue instructions on this subject does not show that there is a legal obligation on the Company to cut the grass during the whole length or any part of the length of its railway system. The rulings on the subject, which have been brought forward, are as follows—

In 14, Bengal Law Reports, p.1, C. Halford *vs.* The East Indian Railway Company there was a case before a learned single Judge in Calcutta which was taken in appeal before a Bench of the Calcutta High Court. In that case the plaintiff claimed damages on the ground that the Company had allowed grass of too great a length to remain on the railway banks and had driven an engine along the line without due precautions being taken to prevent the expulsion of sparks. It was held that the defendant Company was authorised to run locomotive engines on the line of the railway constructed by the Company under the statutory powers given to it and therefore the Company was not liable for damage caused in making the line under

such statutory powers without proof of negligence. It was held also on the evidence that neither in the construction of their engines nor in the condition of the railway banks was any negligence shown on the part of the Company. The plaintiff's land was separated from the railway by a fence and there was a stable and some other constructions and a bungalow and two heaps of thatching grass were lying on the plaintiff's land. The eastern bank of the railway and the cutting was covered with growing grass. On p. 7 reference was made to evidence to the effect that the grass was only six to eight inches long and on the other hand the evidence of the plaintiff was that it was six feet in length and had been cut and two feet of the grass was left standing after cutting. The Court found that the grass was about a foot high and that the existence of grass of that height would not be evidence of negligence against the Railway Company. The Company had left trimmings of cut grass along the place where the grass was cut. The Bench on appeal upheld the finding of the learned single Judge that the existence of grass in that condition did not amount to negligence. Now it is to be noted that in the present case the Railway Company had not cut the grass. In the Calcutta case there was a case of alleged misfeasance, that is, that the Railway Company had cut the grass in a manner which was negligent by allowing too much grass to remain after cutting and by allowing certain grass which had been cut to remain lying on the spot. In the present case the plaintiff has a weaker case as he has alleged non-feasance on the part of the Railway Company and he has to show that the Railway Company had a positive duty to cut the grass between the fencing. The only case of this High Court to which reference has been made is a case of civil revision reported in 25, A. L. J. 336, the Secretary of State for India in Council *vs.* Dwarka Prasad. In that case there was no question of grass but the trial Court had held that there was negligence on the part of the Railway Company because the drivers of two engines were negligent in racing and further the Court held that it was not established that spark protectors had been used on the engines. On this finding of negligence the decree for damages was upheld. That case, however, is distinguished from the present case

that there was any negligence on the part of the driver or that the engine was in any way defective in construction. Learned counsel attempted to remedy this defect in his plaint by arguing that there might be some such defect in the construction. But in the absence of any such allegation in the plaint and any evidence before the courts below it is much too late to make a new suggestion of this kind in Letters Patent Appeal.

In Smith *vs.* The London and South-Western Railway, L. R. 5. C. P. 98, there was a claim against the Railway Company because the servants of the Company had allowed cut dry grass to be on the line of the Company on each side of the railway in what was alleged to be a negligent manner and thereby fire was caused which burnt the plaintiff's cottage. This, however, was a case of allowing cuttings and trimmings of grass to remain after the grass had been cut on the banks of the railway in a season of unusual heat and dryness, and Bramwell, C. J., in his judgment, held that this might be evidence from which a jury might presume negligence. In the present case the plaintiff does not allege that there was any cut grass lying on the *patri* which might have caused the fire, but his complaint is that there was standing grass which had not been cut. In England the question of claim against a Railway Company has been settled to a certain extent by the Railway Fires Act, 1905, and in that Act it is provided that negligence need not be proved against a Railway Company where damage is done to agricultural lands or agricultural crops by sparks or cinders from the railway engine and where a sum of money not exceeding £100 is claimed provided due notice is given to the Railway Company, but in cases where damage exceeding £100 is claimed then it is necessary for the plaintiff to prove negligence on the part of the Company. In India there is no provision of law similar to the Railway Fires Act and, therefore, it is necessary for the plaintiff in the present case to prove negligence. In the Canadian Pacific Railway *vs.* Roy, L. R. A. C. 1902, p. 220, there was a case before their Lordships of the Privy Council from the province of Quebec in Lower Canada where the plaintiff had suffered damage caused by sparks escaping from a locomotive engine. It was held that because the Civil Court of

Lower Canada and the Dominion Railway Act did not impose any liability of this nature on a railway company acting within its statutory powers therefore the Railway Company was not liable for the damage caused by the sparks from their engine. The judgment proceeded on the ground that it was necessary to establish definitely negligence on the part of the Railway Company. At p. 231 the Lord Chancellor stated : "The Legislature is supreme and if it has enacted that a thing is lawful such a thing cannot be a fault or an actionable wrong. The thing to be done is a privilege as well as a right and duty." The case of Canada is, therefore, distinct from the case of England, because in Canada there is a Dominion Railway Act. In England there is no general Railway Act, but the different companies obtain statutory authority provided by Acts of Parliament. In India the case is similar to the case of Canada because there is a general Act, the Railway Act of 1890. This judgment, therefore, is some authority for the proposition that in the default of a provision in the Railway Act of 1890, the Company cannot be liable for exercising its statutory powers of running railway engines on its lines. None of the rulings which have been laid before the Court show that there is any duty of a railway company either in England or in India to cut the grass on the banks of its railway lines. In the absence of any authority of this nature it is difficult to hold *primâ facie* on prior considerations that there is such a duty of the Railway Company. The courts below and the learned single Judge of this Court have not indicated where the legal duty is imposed on a railway company to cut the grass on its banks. The absence, therefore, of any authority for such a proposition makes it difficult to accept the findings of the courts below that there was negligence by a breach of the Railway Company of this assumed duty.

Now, the other part of the argument of learned counsel for the appellant, based on ground No. 5, is that even if there was negligence on the part of the Railway Company in committing a breach of the assumed duty still the plaintiff cannot recover damages because the plaintiff was guilty of contributory negligence. This argument has been based on the admission of the plaintiff that he was aware, since

the year 1927, that there had been occasionally such fires caused by sparks from the railway engines. In spite of that knowledge the plaintiff allowed his *patel* grass which is grass of a considerable height about six or eight feet to grow up to the railway fencing. It would have been open to the plaintiff to keep a certain area about 10 feet wide free from grass and such an area parallel to the railway fencing would have acted as a fire-line and if a fire had started on the grass inside the railway fencing such a fire could not have spread to the *patel* crop of the plaintiff. There was further negligence of the plaintiff in the method which he adopted in cutting his field. He cut the field in the part remote from the railway and stacked 12 stacks of grass amounting in value to Rs. 420. At the same time he left the *patel* crop standing adjacent to the railway line. There was, therefore, a means of communication of the fire between the railway line and his stacks of *patel* grass which are found by the courts to have been 50 or 100 yards from the railway fencing. It is obvious that if the plaintiff had adopted the sensible method of cutting his *patel* grass adjacent to the railway line first then it would not have been possible for the fire to spread to his stacks of *patel* grass. Learned counsel for the respondent has not been able to explain why the plaintiff did not adopt this simple precaution. This does appear to amount to contributory negligence on the part of the plaintiff and accordingly this furnishes another reason why the decrees of the courts below should be reversed. The courts below do not appear to have approached the subject from this point of view. Where a man is well aware that a danger may result from the use of railway engines in a statutory manner and where that man grows a crop of an inflammable nature close to the railway line, it is a matter of ordinary precaution for him to place a fire-line between his crop and the railway fencing. Learned counsel addressed some arguments for us that the omission to grow *patel* grass on a fire-line 10 feet broad would cause a large amount of loss to the plaintiff. That argument is however, shown to be incorrect by a consideration of the value of the crop and the area on which it is grown. *Patel* is not at all a valuable crop and the omission of a small area would be a matter of no importance from the financial point of view.

For these reasons I consider that this Letters Patent Appeal should be allowed and the suit of the plaintiff should be dismissed.

(Sd.) E. B.
13-12-1935.

By the Court.

The appeal is allowed, the decrees of all the courts are set aside and the suit of the plaintiff is dismissed. In the circumstances we direct that the parties should bear their own costs throughout.

(Sd.) S. M. S.
(Sd.) E. B.
13-12-1935.

REVIEWS

OUR FORESTS.

By F. C. Ford Robertson, I.F.S. Price As. 12.

(Obtainable from Superintendent, Printing and Stationery, U. P.)

This treatise draws a clear picture of the United Provinces forests in non-technical language for the layman in all its bearings on the life of dwellers in the hills and the plains. To the average educated man in India forestry means little more than merely cutting of trees for revenue and this small book fulfils a long-felt need and presents in a clear and concise manner all information necessary to enable a citizen to appreciate the value 'and importance of forests on the economic

life of the people. It gives an outline of the history of the United Provinces forests from the days when forest conservancy was first undertaken and a valuable public estate was saved from the devastating hand of man and beast. It then describes the nature of present forests of the United Provinces in the hills and the plains. Chapter III deals with the organization of the Forest Department and its working. In Chapter IV a description of various types of damage done to the forests gives interesting glimpses into natural history. The writer brings home to the reader in a forceful and piquant language the agencies for which man alone is responsible, directly or indirectly, for the damage to forest growth. The effect of gradual destruction of soil cover on erosion in the hills and on water supplies in the rivers and consequently on canal systems and wells in the plains is explained. In Chapter V a brief account of chief timber trees of U. P. and their uses is given. A strong appeal is made for a larger use of indigenous timbers which can successfully compete with the imported timbers like aspen, hickory and ash.

The various minor products of U. P. forests and their by-products are then discussed in detail.

It would be very useful if this book could be translated into the vernaculars of the province so that a larger number of the people could benefit by it. In fact it would not be too much to suggest that the Educational Department should be asked to include this in the list of books for extra reading in the High Schools and it should find a place in all school libraries to give the growing boy a consciousness of the value and usefulness of the forests of his province. It is a good general knowledge book and is well illustrated. The U. P. Forest Department is to be congratulated on its production.

A. B.

PRACTICE OF SILVICULTURE

BY RALPH C. HAWLEY, MORRIS K. JESUP, PROFESSOR OF SILVICULTURE, YALE UNIVERSITY, U. S. A.

(*Third Edition, John Wiley and Sons, Inc. New York.*)

Professor Hawley's "Practice of Silviculture" first appeared in 1921 when Schlich's Manual of Forestry Vol. II was practically the sole work on the subject in the English language. Designed, as it was, chiefly for the class-room, Professor Hawley's text-book fulfilled a long-felt need of the student in American Forestry. The sustained demand for this valuable treatise on silviculture has now made it possible for Professor Hawley to produce a third edition of his text-book, revised and amplified in the light of recent developments in American silviculture.

2. The American flora, rich and varied as it is, renders it practically impossible to incorporate fundamental elementary principles governing the growth of individual trees and crops (*silvics*) in a text-book on silviculture dealing mainly with the tending and reproduction of forest crops. A knowledge of *silvics* has been, therefore, assumed by the author. Nor has any attempt been made to deal with the silviculture of forest crops species-wise except by way of illustrating a principle by concrete examples.

3. A forest may be reproduced either from seed or from root stock. The former secures the propagation of forest species both in *time* and *space*, while the latter only in *time*. The technique employed in obtaining reproduction coupled with the manipulation of the upper canopy culminating in its ultimate removal to secure conditions expediting the establishment of young regeneration provides the basis of Professor Hawley's classification of silvicultural systems. He has confined himself to a clear-cut description of the following methods characteristic of the American silvicultural practice—

A. *High Forest Methods*, reproducing forests from seed.

1. Clear-cutting method.
2. Seed tree method.
3. Shelterwood method.
4. Selection method.

B. *Coppice Methods*, reproduction secured by vegetative propagation from root stock.

1. Coppice method.
2. Coppice with standards method.

4. In actual practice, however, the objects of management, locality and species often suggest modifications of the systems described above resulting in a variety of methods generally distinguishable from each other only by the intensity and the nature of the reduction of overwood and the regeneration technique employed. The European text-books enumerate a vast number of silvicultural methods which on ultimate analysis will be found to be a variation of one or the other or a combination of the standard systems described by Professor Hawley. A separate chapter has been allotted to each of the silvicultural methods outlined above and important modifications have been dealt with in some detail. A discussion on the advantages and disadvantages of each method forms a useful feature of the chapters allotted to the description of silvicultural systems.

5. The tending of forest crops by intermediate cuttings has been dealt with in great detail. The terms "cleaning" and "weeding" have been treated as synonymous and the distinction to which we have been hitherto used has not been recognised. Operations described as "liberation cutting," thinning and improvement cutting are hardly distinguishable from each other, if it is remembered that the chief aim of all intermediate cuttings is identical, *viz.*, the cutting of trees, the removal of which would increase the value of the remaining crop in terms of money.

6. A useful chapter has been added on slash disposal. Forest protection forms the subject matter of the last 9 chapters, a feature not usually associated with text-books on silviculture. Special emphasis has been laid on forest fires which have been dealt with in great detail.

7. Literature cited in the text appears at the end of every chapter to provide supplementary reading for the student. American publications are noted for their neat get-up and this book is no exception to the general rule.

M.D.C.

REPORT ON FOREST ADMINISTRATION IN BURMA, 1934-35

From a financial point of view the report under review indicates a distinct improvement over last year's report. The surplus amounted to Rs. 57,60,346 as against Rs. 18,03,773 last year, but is nevertheless still below the average for the pre-slump period 1925—30 when the surplus for the province was Rs. 1,13,30,029.

The major portion of the increase in revenue was due to an increase in the sales and prices of teak, but an improvement in the market of other hardwoods, bamboos and cutch also helped to swell the total. Expenditure showed a decrease of over 5 lakhs and was only 68·5 per cent. of the average of the pre-slump years.

In commenting on this the Chief Conservator of Forests expresses the opinion that expenditure has been reduced to a figure far below that required for bare maintenance and that if the present policy is continued the capital value of the Burma forests will be impaired and that this will lead to a reduction of the yield.

Unfortunately there has been a great tendency in recent years to regard the future forest revenue of Burma with misgivings, and we are pleased to read that the present Chief Conservator of Forests believes that such pessimism is unfounded, and that he sees in the increase of forest revenue recorded above distinct signs of recovery. After analysing the position of affairs in more detail he records his opinion that it would be to the lasting discredit and loss of the country if forests are now starved. With this opinion we are in entire agreement and we hope that a sympathetic and statesmanlike view of the situation will be taken by the authorities concerned.

The remainder of the report follows the usual lines, but it may be mentioned that the old methods of calculating yields in the teak forests of Burma have been found wanting and a new policy has been outlined.

The controversy on the plantation question has also been settled and Government have issued a statement on the new policy to be adopted and favouring natural regeneration rather than plantations.

FLORA OF WEST TROPICAL AFRICA, VOL. II, PART 2

BY J. HUTCHINSON AND J. M. DALZIEL.

Issued by the Crown Agents for the Colonies, 4 Millbank, Westminster, London, S. W. 1. February, 1936. Price 8s. 6d.

The two parts of the first volume of this Flora were published in 1927 and 1928 ; the first part of the second volume appeared in 1931 and the present issue of the second part completes the work. This issue covers the Monocotyledons for which Dr. J. Hutchinson is responsible except for the Orchidaceae, comprising some 60 pages of the book, which is the work of Mr. V. S. Summerhayes. The work is arranged according to the classification proposed by Dr. Hutchinson in Part II of his *Families of Flowering Plants* (1934) and a revised Key following this classification is included in this issue. The Flora has been drawn up on very modern lines with excellent comprehensive keys ; the notes under the species include the distribution and some useful references to botanical literature and herbarium collections. As in the previous issues there are many well executed drawings by W. E. Trevithick and other artists which add to the value of the work. The present issue includes a vegetation map of the area covered by the Flora and a complete index to the families, genera and species. The price is uniform with those of the previous parts. The authors and the authorities of the Herbarium of the Royal Botanic Gardens, Kew, are to be congratulated on the speedy completion of this most useful work.

C.E.P.

EXTRACTS

PLYWOOD AND VENEERS SECTION

PROBLEMS OF PRODUCTION WITHIN THE EMPIRE

(CONTRIBUTED.)

The question of plywood origins is again much to the fore in connection with the disclosures made of the quantity used in constructional work at the British Industries Fair and the negligible contribution of the Empire to its production.

The fact that the Empire production of untreated commercial plywood *is less than one per cent.* of its consumption emerges clearly from the information available

from published returns. That the fact is not one of which we have any reason to be proud must be admitted; but where does the blame lie? From the way in which the position is stated by some of the advocates of Empire trade, the general public is left to assume that there is some wicked conspiracy on the part of merchants and users to boycott Empire plywood for the benefit of foreign suppliers, with whose financial interests they are presumably in some way identified. The assumption is not a just one, and there is little merit in broadcasting the existence of an undesirable state of affairs without troubling to ascertain its causes or indicating some practicable steps for their removal.

In the first place, it is totally wrong to assume that any part of the Empire is at present in a position to offer supplies of plywood of such a description or in such quantities as the British market calls for; in the second place, such supplies as the Empire does offer are produced with very little regard to the nature of the demand, being limited by the locality and conditions of their manufacture and affording no suitable substitute for present supplies; and in the third place the price levels which are assumed to be necessary to justify extensions of production adequate to cope with a substantial portion of the demand are too high in relation to foreign prices for the difference to be bridged by tariffs or sentiment, or by any combination of both which is within the scope of commercial possibility.

Finding a Remedy.

These factors, which are well known to those whose interest in the matter goes beyond its potentialities as an argument in support of a particular policy, do something to relieve the demand side from the sole responsibility, and spread part of it upon prospective producers and part upon circumstances beyond the control of either producer or consumer.

To shift the blame, however, is not to get much nearer to a remedy. To do this it is necessary to keep plainly in view the conditions influencing the demand, and then see where these conditions exist or whether they can be provided. The following may be regarded as the prime essentials for an undertaking seeking to secure a good footing in the British plywood market with reasonable prospects of success—

(1) A manufacturing site within easy reach of a dependable supply of logs, sufficient to last for a number of years, and also with cheap and convenient access to a port of shipment.

(2) A reliable supply of labour at low monetary wages.

(3) Not less than £100,000 capital, content to wait a year or two for returns, and then to accept reasonable interest with small prospect of spectacular profits.

(4) Facilities for the acquisition or generation of a moderate amount of power at cheap rates.

(5) Close contact with the demand side and sufficient elasticity to modify standard methods of production in response to changes in consumers' requirements.

It will be seen at once that the conditions are not easy, and it is no use attempting to conceal the fact that the commodity, while it should rise well above present

price levels, is not at all likely to carry either high wages to its semi-skilled labour or large dividends on its capital. Both these factors are low in present sources of supply, and even if foreign competition is severely restricted by increases in tariffs or other means, and the price level is raised to the point where it would seriously menace the volume of consumption, that point is hardly likely to be high enough to encourage extravagant hopes of a large surplus over costs.

The conditions as to locality in relation to raw materials and distribution can no doubt be met in various parts of the Empire, but those affecting the supply of labour are not so simple. Still, it should be possible to recruit labour where a comparatively high standard of subsistence can be secured at low monetary cost.

Financial Considerations.

The financial aspect explains why private enterprise has failed to establish plywood manufacture on a large scale within the Empire. It simply will not carry heavy timber royalties and the commissions and promotion profits which are a usual feature of commercial flotations. Capital is being asked to finance a branch of manufacture which has had very little profit, and borne some heavy losses, in the last decade.

The manufacture of plywood is not one of the industries which have been wrested from us by foreign competition, nor one which the natural resources of the British Isles in raw materials suggest as a large-scale home industry. On the contrary, to undertake it we should be invading a field which certain other nations possessing large forest resources have made peculiarly their own. We can only do it by calling on the resources of the Empire overseas, and even this must mean a definite subordination of the desire for a cheap product to the political and social considerations which dictate a preference for Empire products.

It is probable that we should be wise to undertake the venture, and certain that if costing estimates were tackled in a spirit less concerned with profit than with a desire to expand industry and employment, the price divergence could be reduced to negotiable proportions. The question is whether the desire to see our Empire resources in labour and materials made available for our needs is sufficiently strong, or sufficiently widespread, to induce us to face the difficulties and risks involved.

Any serious attempt to bring Empire plywood into a fair share of the British market would meet with every possible sympathy and support from British distributors, and there are many users who would give it a strong preference if it was available. There are, however, limits to both the possible substitution of less suitable material and to the higher price which can be paid. The market has yet to see a determined assault made by Empire producers upon these obstacles.

If those who regard the present origins of plywood supplies with so much dismay would devote their abilities to a careful examination of the best means of bringing about a better state of things, they would be brought in close contact with the problems which beset all those engaged in the trade, and constructive action might take the place of useless recrimination.—(*Timber Trade and Saw Mill Advertiser*, 29th February 1936.)

The following information is extracted from the Seaborne Trade and Navigation of British India for April 1936—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	MONTH OF APRIL			MONTH OF APRIL		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER				R	R	R
Deal and pine wood cubic tons	1,365	843	1,283	89,964	54,399	79,635
Jarrah wood .. ,,	..	..	..	..	..	..
Teak wood—						
From Siam .. cubic tons	846	..	..	79,436	..	..
,, French Indo-China ,,	..	..	1,295	..	..	1,28,712
,, Other Countries ,,	..	..	..	..	..	..
Total .. ,,	846	..	1,295	79,436	..	1,28,712
Firewood .. .. tons	43	58	39	656	866	555
Sandal-wood .. .. ,,	43	21	8	13,992	10,868	2,044
Sleepers of wood for railways .. .. ,,	..	..	..	..	..	..
Logs and timber for matchmaking .. ,,	..	..	1,239	..	..	71,482
Other kinds of wood and timber .. ..value	..	..	..	1,57,792	1,76,255	27,673
Plywood and other laminated wood, *other than* veneers for matchboxes .. tons	..	..	331	..	..	66,434
Manufactures of wood, *other than* furniture and cabinetware .. value	..	..	..	1,67,934	1,89,579	1,44,300
Total of Wood and Timber ,,	..	..	..	5,09,824	4,31,967	5,20,835

EXPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of April			Month of April		
	1934	1935	1936	1934	1935	1936
Wood and Timber						
Teak wood—				R	R	R
To United Kingdom cubic tons	87	265	3,618	15,455	54,843	7,13,667
,, Germany .. ,, ,,	33	234	330	7,338	57,437	77,679
,, Belgium .. ,, ,,	8	..	..	1,217	..	..
,, Iraq .. ,, ,,	51	38	27	8,957	8,346	8,145
,, Ceylon .. ,, ,,	10	50	188	1,260	5,500	30,344
,, Union of South Africa .. ,, ,,	226	..	393	53,723	..	79,872
,, Portuguese East Africa .. ,, ,,	2	..	224	636	..	34,902
,, United States of America .. ,, ,,	..	..	59	..	..	17,413
,, Other Countries ,, ,,	108	75	209	15,650	18,478	46,578
Total .. ,, ,,	525	662	5,048	1,04,236	1,44,604	10,08,600
Share of Bengal ..cubic tons	..	9	..	..	2,223	..
,, Bombay .. ,, ,,	133	112	85	23,018	26,586	19,846
,, Sind .. ,, ,,	1	..	..	229	..	..
,, Madras .. ,, ,,	40	12	17	2,939	460	1,267
,, Burma .. ,, ,,	346	529	4,946	78,050	1,15,335	9,87,487
Total .. ,, ,,	525	662	5,048	1,04,236	1,44,604	10,08,600
Teak Keys .. tons	..	91	331	..	13,650	48,000
Firewood .. ,,	..	15	..	..	250	..
Hardwood (*other than* teak)—						
To United Kingdom cubic tons	..	..	35	..	..	3,550
,, Other Countries ,, ,,	..	..	11	..	..	1,708
Total .. ,, ,,	..	..	46	..	..	5,258
Sandal-wood—						
To United Kingdom .. tons	..	1	1	..	400	600
,, China (*excluding* Hong-Kong) .. ,,	..	..	..	..	..	..
,, Japan .. .. ,,	..	2	6	..	2,400	8,000
,, Anglo-Egyptian Sudan ,,	4	5	9	3,555	5,990	11,615
,, United States of America .. .. ,,	55	5	50	63,500	3,650	50,000
,, Other Countries .. ,,	3	1	4	4,830	2,525	7,462
Total .. ,,	62	14	70	71,885	14,965	77,677
Other kinds of wood and timber .. .. value	..	..	..	27,191	13,481	21,719
Manufactures of wood, *other than* furniture and cabinetware .. .. ,,	..	..	..	13,347	8,673	8,739
Total of Wood and Timber and Manufactures thereof ,,	..	..	..	2,16,659	1,95,623	11,69,993

INDIAN FORESTER

SEPTEMBER, 1936

DISFORESTATION

When I first read Amimad Orishe's article in the May number of the *Indian Forester*, I admit having been somewhat surprised at its appearance and I anticipated that there would be no support for his views or for his manner of expressing them. Apparently, however, he was correct in assuming that he would obtain some support, hence it appears necessary for more of us to express our views, so that misunderstandings may not arise either in India or outside amongst our readers as to the general attitude of the Department.

It was my lot to work in a hill district as Divisional Forest Officer during the three years' course of a very extensive modern Forest Settlement including the demarcation of the forests. It was the Revenue Department who had first asked for the Forest Settlement after finding that the increasing pressure on these forests had made further management by them impossible, the Revenue Officer acting as Forest Settlement Officer. The Forest Officers who were his assistants were first class officers. The utmost harmony existed between Revenue and Forest Officers and I have no doubt that there will be many, who have worked with Revenue Officers, who will not be surprised to know that at times it was the Revenue Officer who pressed us to take up forest areas, which we would have left as we did not think it was in the public interest to reserve them. The demarcations, the inspections and valuations of the forest and the enquiry into and allocation of rights, were all carried out with the greatest care.

All of us concerned in this settlement then gradually left the district. Before long, coinciding with a period of political agitation, organised opposition arose to the enforcement of the provisions of this Forest Settlement.

A

A grievances committee was appointed and made recommendations which Government accepted. It is now admitted by public opinion that these recommendations were too hastily conceived, and in some cases went too far, and the best that can be said for them is that conditions were at the time very serious and remedies, even if only temporary, had to be found.

Subsequently that Forest Settlement Officer became Commissioner (now some years retired) and I became Conservator of that tract. Public opinion was still very sullen. The reposting of two officers concerned in the settlement was viewed with great suspicion. The Legislative Council in successive years made cuts of a lakh and two lakhs in the budget estimates and certification of the funds was necessary. At that time had "Forests" been transferred in our Province, we should probably have lost the remainder of the reserves left by the grievances committee under State control.

Though of very great value locally to the people and essential from the hill-protection point of view, these forests are not capable of producing any very high revenue. They pay their way but a very expensive staff cannot be afforded and it is doubtful whether any staff would suffice to ensure satisfactory protection and management of these forests in opposition to general public opinion.

It was most disheartening to find that so much of the work done in the settlement had been thrown away by the subsequent course of events, but the latter taught very important lessons. The rising power and importance of public opinion must be given full consideration and the pace of progress must be regulated with the development of public opinion.

The first essential here was to gain the confidence of the people in the aims of forest administration and to educate public opinion and gradually lead up to the stage, when the necessity in some cases for subordinating local needs to the general interests of the State would be appreciated.

A local advisory committee was instituted consisting of members of Council, nominees of the district boards and of Government and only two Government officials, thus including supporters of forestry

and some of our strongest opponents. From the commencement their work has been of the greatest value : the members have formed connecting links with the public in making known the aims of the Forest Department and in advising us when proposed measures would result in difficulties that would best at present be avoided.

The change in attitude in the past ten years has been phenomenal. Even those formerly the stoutest opponents now co-operate. I would cite the case of a gentleman who went to prison in one outburst of agitation after preaching the burning of our forests. At the end of his first attendance at a meeting of the committee he agreed to use the paper, of which he was editor, to further the aims of the committee and later, in a very dry and dangerous year, he addressed public meetings in the district, saying the forests should be protected from fire.

We have arrived at no state of perfection—very far from it. But we can face the coming constitutional changes with the feeling that local public opinion will now insist on the retention of these forests. We have requests for plantations to be retained by the Forest Department and for new ones to be made, where formerly the opposition was so great that for about 20 years no new work of this nature was taken in hand. We have villagers in considerable numbers taking up the enclosure, protection and formation of new forests at their own expense, partly under legally instituted rules and partly on their own initiative in imitation of the official village forests.

We still have to do much that is contrary to the ideas of efficient forestry and, amongst other things, we have to meet constant pressure for disforestation. In this tract the population has increased 10 per cent. in the last ten-yearly census period and the pressure on the land has increased vastly. On the other hand even the modified extent of improved management that we have been able to introduce has increased the yield of our forest. Thus in many parts the extent of forest reserved primarily for local needs and considered necessary at the time of the settlement for that purpose is no longer so necessary.

It would be unfair and unreasonable to assume the attitude in such cases that what we have we must hold even though it can be put to better use. It is not assumed that mistakes were never made in the course of the settlement; such an assumption would be ridiculous to those who have experience and know the extent of the records involved and the difficulties that villagers in remote tracts have in stating their claims during the period of enquiry. The best rules and organisation will still leave cases where, on subsequent further personal investigation, improvement is possible. It is certainly reasonable to assume the orders of the Forest Settlement to be correct until they are proved to the contrary. It is certainly unsound to encourage any general demand for revision of the orders of a settlement. *But it is not sound to refuse to consider complaints* even on their merits. Blank refusal merely antagonises public opinion and sets back the progress of forestry. The sanctity of recorded rights, as at present established by law, need not be infringed, but concessions can be granted when necessary to meet cases of real hardship. One of the most difficult things no doubt is to draw the line between undue generosity and harshness in this matter ; the higher official may tend to press for generosity and the local officer find the difficulties resulting from excessive demands, if too much is given away. Close touch between the higher officials—of all services—and the local officers and the people should, however, result in a sound middle course being steered, and the best interests of forestry will be served.

It may be said that most of the above is based on experience of a recent Forest Settlement. In the case of the older settlements it is generally impossible to say that mistakes were originally made, when hardships now are apparent. The period concerned is too remote to hope that enquiries would give useful results and still more must the assumption be that the old orders were at the time suitable and correct. Conditions will generally have stabilised themselves much more and the need for changes should be much less frequent, but even here refusal to consider anything regardless of the merits of a case is not sound administration.

Now for the final point raised in the penultimate paragraph of the article. Part of what is there written might be a paraphrase of what I said myself to my Chief, a fair number of years ago, in very enthusiastic support of my views on a matter in dispute, when I thought that the forest point of view was not being placed before Government. The Chief's argument, then, to me was that general policy has to be considered even by him in recommending to Government.

I pass this on now in my turn. Times have been changing, and the changes shortly about to come will be still greater. Lucky is the province where the policy of Forest Management has already gradually adapted itself to popular control and half their troubles are already past and we may hope that the change will be made without any radical effect on the progress of forestry. That must be our aim for the future ; the Forest Department can be no water-tight compartment of administration, any attempt to fight its battles relying only on its own strength based on efficiency of methods, and disregard of public opinion can hardly result in success. Public opinion must be educated in forest matters, public confidence must be retained or gained and the future progress of forestry will depend on public support. It may be that it is for the higher officials to define the details for carrying out this policy, but all can help by recognising the need for this attitude and for furthering this aim by reasonable consideration and treatment of the problems that confront them.

F. C.

A CHEAP AND EFFICIENT ELECTRIC MOISTURE METER FOR WOOD DESIGNED AT THE F. R. I., DEHRA DUN

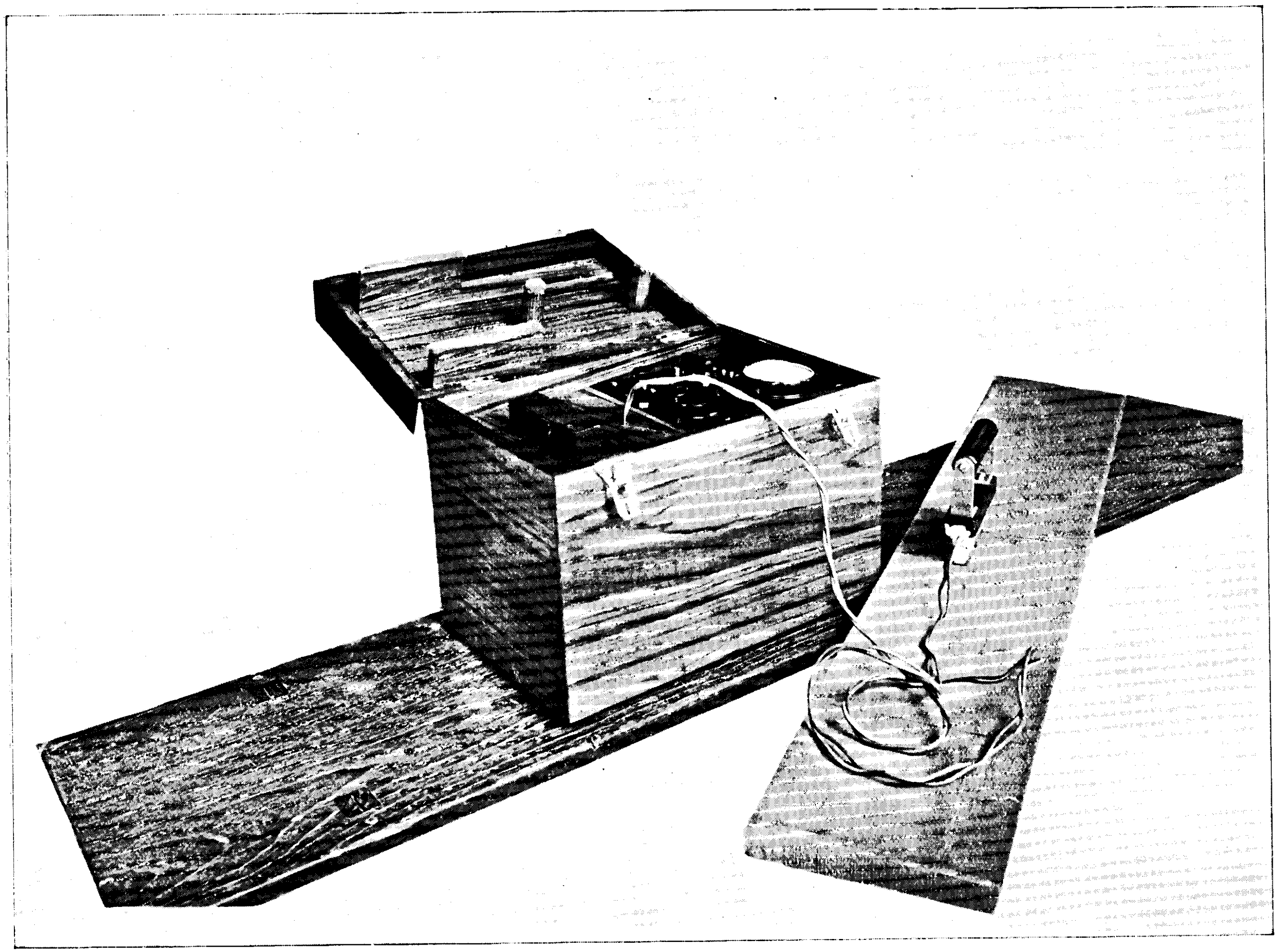
BY S. N. KAPUR AND D. NARAYANAMURTI

The determination of the moisture content in wood is an important step in the utilization of wood for all purposes where seasoning wood before use is essential, such as in the manufacture of furniture and cabinet-ware, tool handles, railway carriages, sleepers for railway lines, and in building structures. The usual method of determining

the quantity of moisture in a piece of wood is by the oven-drying method, in which a small sample, either in the form of an entire section or borings, is dried in an oven at about 100° C. for 24 to 48 hours. The method has, however, the drawbacks that in the process of obtaining a test sample the piece is damaged, and the results are not immediately available. There are various physical and mechanical properties of wood which vary with the moisture content within certain limits and which could be employed for moisture content determination. Some of these are density, dimensional changes, hygroscopicity, strength, hardness, thermal conductivity, specific heat, resonance, dielectric constant and electric resistance. In a recent issue of this Journal (July 1935, page 435) a description was given of the various methods which have been successfully employed for rapid determination of moisture content of wood, and it was shown there that the electric resistance method is the most convenient to employ within the range of moisture content, 7 per cent. to 24 per cent.

A large number of instruments for indicating moisture content of wood, based on this principle, have been put on the market by various firms in Europe and America, and while some of these are satisfactory in use, others are not suitable for use in this country, where the atmospheric humidity is very high during the monsoon season and where the moisture gradients in wood during seasoning are rather steep on account of the refractoriness of most of our hardwoods. The Tag-Heppenstall moisture meter has been found to be the most suitable, but even this fails to work satisfactorily during very wet weather. Moreover, the cost of an instrument landed in India varies from Rs. 700 to Rs. 1,200, which is much too high for any of these meters to find a market in this country.

Since the publication of the article referred to above, a number of enquiries have been received from woodworking firms, forest officers and railways asking particulars about electric moisture meters, and it was considered desirable to investigate whether it is possible to build a meter in this country at a reasonably low cost, which would give satisfactory service under tropical monsoon



F. R. I. MOISTURE METER FOR WOOD

conditions. A study of current scientific literature also showed that the electrical resistance of wood has not yet been exhaustively studied under varying conditions, and that the resistance values for wood assumed for the construction of these instruments show wide variations. The present investigation was, therefore, taken in hand to study the electrical resistance of common commercial species of Indian woods at various moisture contents, with a view to designing an electric moisture meter suitable for Indian conditions.

The preliminary experiments carried out so far have yielded good results and an instrument based on this principle, equipped with special type of needle contacts, has been constructed, the current being amplified by a thermionic vacuum tube amplifier. Care has been taken in the design of the amplifier to ensure satisfactory operation. Trials carried out in this laboratory have shown that knife-shaped needle electrodes show a better penetration into Indian hardwoods than round ones. A number of improvements have been made in the design and construction of the instrument, which will be described in another paper in due course.

Arrangements have also been made to import direct from abroad component parts required for the manufacture of these instruments at special trade rates, and it is estimated that an instrument can be assembled at a cost of not more than Rs. 140 inclusive of the dry batteries required for working the instrument, if built in large numbers. As the manufacture of these instruments requires considerable technical skill, and their testing can only be done in a well-equipped laboratory, in the early stages, it would be most convenient to get the instruments manufactured at Dehra Dun. As the cost of an instrument is less than one-fifth of the cheapest of the imported electric moisture meters, it is hoped that these meters will find extensive application in this country. Plate 39 illustrates an actual instrument which weighs approximately 24 pounds. The instrument is self-contained and portable, and is quite satisfactory for field work.

Some of the results obtained with this instrument are given in Table 1. A number of pieces of wood were conditioned at different

humidities, so as to avoid any moisture gradients in the specimens. Their moisture content was determined by the Forest Research Institute meter, the Tag-Heppenstall meter and by the oven-drying method and all the results are given in the Table below. The same samples are being conditioned at other humidities, and will be similarly tested. In due course we will have a large amount of data relating to the electrical resistance of most of the important Indian woods.

The results obtained so far indicate that there are a few species, such as semul and gurjun, which show an abnormal variation from the average value, while for the rest of the species the differences from the average are small enough to be negligible. A detailed investigation is in progress to study the effect of species, density, resin content, and other factors on the electrical resistance of wood, and it is hoped that in a short time sufficient data will be accumulated to change the components of the meter to their correct values, and thus ensure, with the help of the calibration charts, its correct operation in the case of most of the commercially important woods.

A vacuum tube amplifier with a ballistic galvanometer and a condenser connected across a resistance in the anode circuit has also been studied and found to operate satisfactorily. A detailed account of this and other work in progress in the Seasoning Laboratory of the Forest Research Institute will appear elsewhere in due course.

Those interested in getting a moisture meter of this nature built for themselves are invited to send their enquiries to the Forest Economist, Forest Research Institute, Dehra Dun, who is making arrangements for meters to be made locally at Dehra Dun.

TABLE 1

Results of moisture tests on various species of wood (specimens conditioned in constant humidity chambers before testing)

Species	Trade Name	Moisture Content: Oven drying %	Moisture Content: Tag-Heppenstall meter %	Moisture Content: F. R. I. meter %	Correction for F. R. I. meter %
Adina cordifolia ..	haldu ..	9·0	..	8	+1
Adina cordifolia ..	haldu ..	7·3	7	7	0
Albizzia procera ..	white siris ..	7·0	7	7	0
Amoora wallichii ..	amoora ..	7·9	8	8	0
Anogeissus latifolia ..	axle-wood ..	7·2	8	8	−1
Artocarpus hirsuta ..	aini ..	7·3	10	9	−2
Bombax malabaricum ..	semul ..	7·1	11	10	−3
Bombax malabaricum ..	semul ..	19·7	..	24	−4
Canarium euphyllum ..	white dhup ..	9·2	..	8	+1
Canarium euphyllum ..	white dhup ..	19·5	..	21	−1
Cedrela toona ..	toon ..	7·8	7	7	+1
Cedrus deodara ..	deodar ..	7·5	7	7	+1
Cedrus deodara ..	deodar ..	10·4	11	11	−1
Cedrus deodara ..	deodar ..	16·1	..	16	0
Cedrus deodara ..	deodar ..	22·7	..	24	−1
Dalbergia latifolia ..	rosewood ..	5·1	7	7	−2
Dalbergia sissoo ..	sissoo ..	5·9	<7	<7	−1
Dipterocarpus turbinatus ..	gurjun ..	7·9	7	7	+1
Dipterocarpus turbinatus ..	gurjun ..	8·9	..	8	+1
Dipterocarpus turbinatus ..	gurjun ..	11·5	9	9	+3
Dipterocarpus turbinatus ..	gurjun ..	18·0	..	<13	+5
Eugenia gardneri ..	jaman ..	7·9	8	8	0
Mangifera indica ..	mango ..	7·0	8	8	−1
Pinus longifolia ..	chir ..	7·7	7	7	+1
Pinus longifolia ..	chir ..	19·4	..	17	+2
Pterocarpus dalbergioides ..	padauk ..	5·1	7	7	−2
Schima wallichii ..	needle-wood ..	6·7	7	7	0
Shorea robusta ..	sal ..	7·5	7	8	0
Sterculia campanulata ..	papita ..	7·0	10	10	−3
Tectona grandis ..	teak ..	6·1	7	7	−1
Tectona grandis ..	teak ..	9·3	8	8	+1
Tectona grandis ..	teak ..	9·5	9	9	+1
Tectona grandis ..	teak ..	16·0	18	18	−2
Tectona grandis ..	teak ..	17·0	18	18	−1
Terminalia bialata ..	white chuglam ..	8·8	..	8	+1

MANDI STATE AND ITS FORESTS—PART II

BY R. MACLAGAN GORRIE, D.Sc.

The previous article (see *Indian Forester* for August 1936) dealt with the Mandi forests and their value to the state. It is now proposed to give an outline of their silviculture and management, including some of the features of the current working plan revision.

Early Development.—The forests of Mandi State have been more fortunate in their history than many other Himalayan forest estates. The first record of exploitation dates from 1880, when a commercial concern called the Mandi Forest Company obtained a lease for deodar extraction at a very cheap rate, and removed most of the mature deodar from the Sutlej forests. The state thus suffered to some extent from the over-felling of its reserve of big trees, but on the other hand the engineering work organised by this company was of a very high standard, and many areas of forest were opened up for development which would otherwise have lain unworked for many years. Indirectly also it has been of great use in giving the local people a thorough training in sawing and the construction of slides and other extraction methods, so that since then there has been a steady demand for Mandi labour in the forest work of Bashahr, Kulu, Kangra, and even further afield. As this work is seasonal the men return to their homes each winter, bringing their earnings with them. To repeat the old Scots saying: "It is an ill-wind that blows naebody guid."

The 1918 *Working Plan.*—Mr. H. L. Wright, I.F.S., was seconded from the Punjab for three years during 1915 to 1918, and with a very small and almost untrained staff managed to compile a working plan and a forest settlement and demarcation in addition to his other duties. Demarcation had previously been restricted to a few shooting preserves. He found that the deodar had benefited greatly from forest rules which had been introduced in 1890, and that many of those formerly felled by the company were more or less fully stocked, as grazing up to that time had not been sufficiently heavy to interfere

seriously with the natural process of regeneration. The practice of lopping deodar had been entirely stopped, but the lopping of kail was still common. Wright's working plan concentrated upon the commercially valuable forests. He had then neither staff nor facilities for handling the lower oak and scrub jungle, which up to that time was used for only moderate grazing, while the chil forests had been completely exhausted by traders' fellings and could only be prescribed for protection.

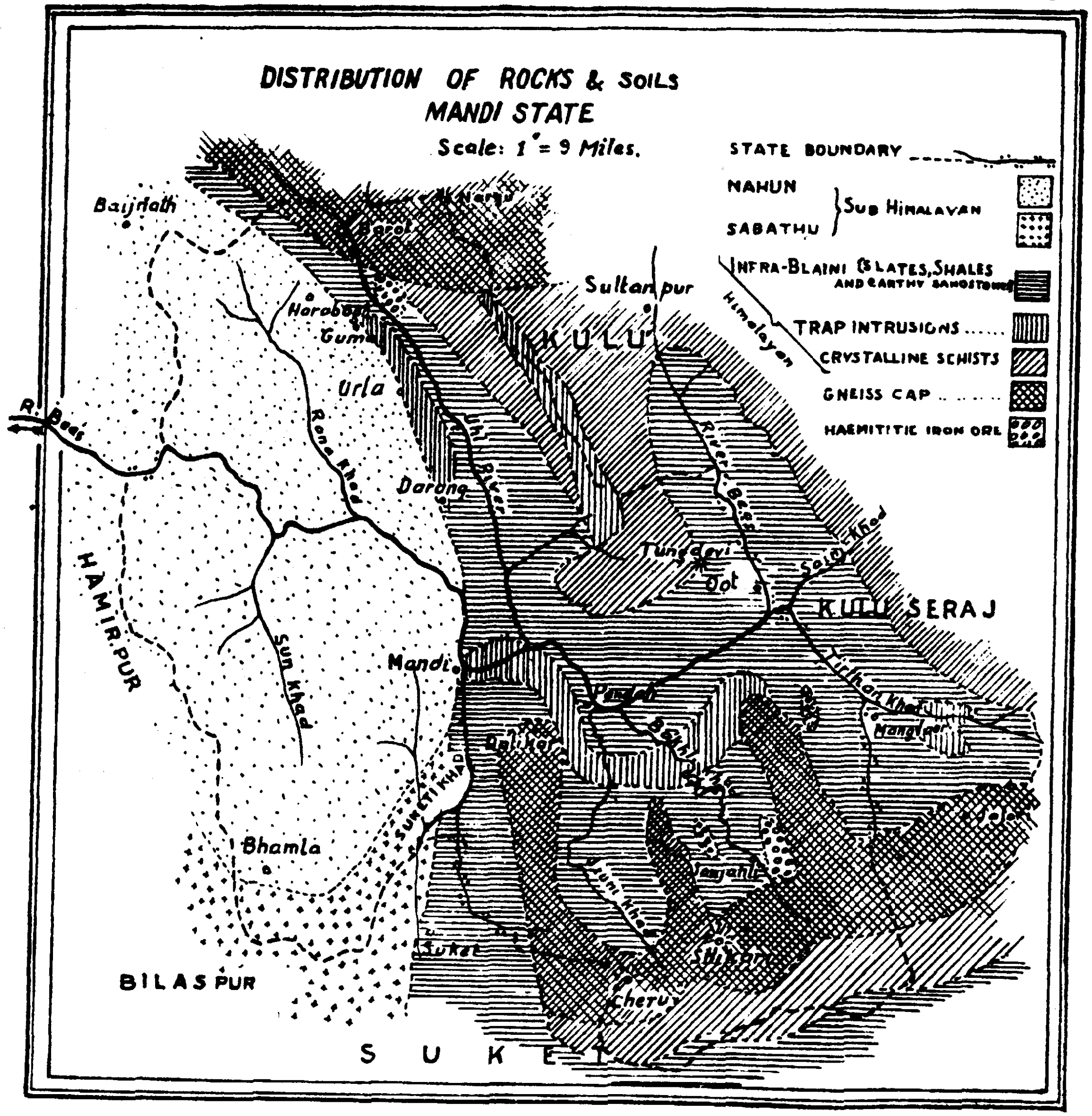
Six working circles were constituted, the deodar-bearing areas falling partly in a Deodar Working Circle and partly in a Thinning Working Circle. Fellings were allowed in the Deodar Working Circle, under Selection marking, 90 per cent. of trees over $7\frac{1}{2}$ feet girth and a proportion of the maturing class, 6 to $7\frac{1}{2}$ feet girth, being added, namely 50 per cent. in the better stocked Sutlej Felling Series and 25 per cent. in the poorer Beas forests. The Thinning Working Circle included immature deodar areas, a proportion of poor chil-deodar and spruce-deodar, and large areas of young kail so badly fungus infected as to be hardly worth the cost of any thinning operation. The remaining working circles were for spruce, chil, fuel supply to Mandi town, and unregulated areas, but some 50,000 acres of undemarcated ban oak, spruce and scrub forest were not included at all.

Wright's plan was admirably fitted for the small and only partially trained staff which the state then employed, and his prescriptions for the more valuable forests proved very practicable, and have been closely followed with much benefit to the forests. The only serious deviation was due to the 1921 fire losses. When the plan was prepared it could not have been foreseen what a great increase in economic pressure, and particularly in the demand for cattle fodder and grazing, would take place during the working plan period, so that prescriptions were confined to forests which were of some timber value. The deodar prescription of 26,000 trees was exhausted in 19 years instead of 20, largely owing to the 1921 incendiary fires and the need for removing trees killed by them. The actual annual yield represented 1·26 per cent. of the enumerated growing

stock in the 19 years, compared with a prescribed yield of 1 per cent. annually over 20 years. That the forests have not been over-felled is brought out by the facts that the prescribed yield has been easily found in each forest, and that the total growing stock has appreciably increased in all size classes. The surplus of revenue over expenditure averaged just over Rs. 2 lakhs annually over the period.

The 1921 *Fires.*—As the only considerable deviation from Wright's plan was caused by the 1921 fires, the fire danger cannot be overlooked, although for many years at a stretch the fire losses are very small. The 1921 incendiarism was almost as widespread in Mandi State as it was in the neighbouring districts of the Punjab and United Provinces. About 37,000 acres of demarcated forest, or about 30 per cent. of the state's total forest, were burnt, and sufficient mischief was done to affect the working of the forests for at least 30 years. The direct financial loss was at least a year's revenue, as the plan has had to be foreshortened by a year, and the expenditure in restocking many hundreds of acres of fire blanks is already considerable. Amongst less obvious losses must be reckoned the loss of increment from areas only now being restocked, and the grazing value and soil fertility, which in many places were spoilt beyond recovery. Erosion losses from the washing away of the exposed and pulverised soil during the subsequent decade must have been somewhere in the neighbourhood of 2,000 tons per acre for many steep areas which failed to produce even a weed crop as a soil cover—for instance a large area of Tarail forest in Kataula range carried a magnificent deodar crop, but has been so bereft of soil that it is now incapable of producing any tree crop at all for many years to come.

The New Plan.—Under the revised plan, which has been prepared by the writer, an effort has been made to assess the value of the forest in terms of its social and economic status apart from revenue production, viewing it not as an isolated unit but as an integral part of the state's property as a whole. The forest can only be maintained at its full productivity if both forest and agricultural lands are put to the uses which will best meet the needs of the state and its residents on a permanently productive basis. The production of a large forest


DISTRIBUTION OF ROCKS & SOILS
MANDI STATE
Scale: 1" = 9 Miles.
STATE BOUNDARY
NAHUN
SABATHU
Sub Himalayan
INFRA-BLAINI (SLATES, SHALES AND EARTHY SANDSTONES
Himalayan
TRAP INTRUSIONS
CRYSTALLINE SCHISTS
GNEISS CAP
HAEMITITIC IRON ORE
Baijnath
Sultanpur
KULU
KULU SERAJ
R. Beas
River Beas
Uhl River
Urla
Darang
Rona Khad
Sun khad
Mandi
Tungdevi
Jot
HAMIR.PUR
Bhamla
BILASPUR
SUKET
Suket
Cheru

revenue surplus is a legitimate and important consideration, but the social values of the forest are also of importance, particularly where the peasants are so dependent upon the forests for many of their daily needs. It has been emphasised that *all* the natural resources of the country should be put on a basis of permanency ; at present the commercially valuable forests are the only natural resource which is being worked in this way ; the non-commercial forests, such as the ban oak and low hill scrub and the non-forest grazing lands, are all deteriorating so quickly with over-grazing that their value is being seriously reduced and their very existence threatened. Future well-being can only be secured if the fodder resources, namely, grass-lands and all types of tree browse and fodder, are used only to such an extent as will guarantee continued productivity. The same applies with even greater force to the methods of field cultivation, which in most of the area are of the primitive shifting-cultivation variety and exhaust the soil in an amazingly short time. In addition to providing the usual felling schedules and cultural prescriptions for the timber forests, an attempt has been made to incorporate measures to reduce the ubiquitous over-grazing and control the widespread erosion and desiccation in field and pasture as well as forest, remembering that the run-off from the Mandi hills forms a source of grave danger and loss to the communities in the neighbouring plains through disastrous floods and sudden changes in run-off in rivers now fully used for irrigation, water power and other commercial purposes.

Deodar Prescriptions.—The better site qualities of deodar have been separated in a Concentrated Regeneration Working Circle with a rotation of 140 years ; in this some 27,000 acres on comparatively easy ground will be worked under the Punjab Shelterwood System. Periodic Block I is a 1/7th of the area and consists of 1,921 burns, already partly restocked artificially but containing many fire-damaged trees ; also other areas in which natural regeneration is already established sufficiently to justify the removal of a scattered and often branchy overwood. Periodic Block II consists of well-stocked areas with a maximum number of maturing trees, though the crops are everywhere so irregular in size that it is almost impossible to find a

real text-book P. B. II. The main object of allotting a P. B. II is to ensure that these maturing trees are given the best possible chance of individual girth increment, but a further important point is the gradual preparation towards a soil condition suitable for successful seeding operations. It has been clearly shown in Kulu and elsewhere that profuse seeding cannot be obtained by making a seeding felling on heavily grazed ground, and that the soil requires a preparatory period of rest in which to recover its natural porosity and accumulate the slightly acid humus in which deodar seedlings thrive. The silviculture in this first period of departure away from the old-fashioned selection will be simple, because there need be no seeding fellings in P. B. I and the marking in P. B. II will be crown thinnings to develop individual maturing trees. Nor is it intended to force any rigid system of shelterwood working in the future, provided that all established crops of whatever age are given an opportunity for their best stems to continue a satisfactory increment. In the remaining 5/7ths of this circle emphasis has been placed upon the need for fairly heavy crown thinnings, because increment borings showed clearly that the local deodar suffers immediate loss of increment if its crown is restricted. Grade E thinnings have been recommended for the better sites and grade C for the poorer ones (See *Indian Forester*, March 1936, "Gradations of Thinning Intensity"). The yield for trees over 20″ diameter for the whole of this circle works out at 9·5 c.ft. per acre per annum.

The poorer deodar sites, such as the pure but slow-growing deodar of the hot southern cliff faces, good deodar areas burdened with heavy rights, and extensive areas of kail, ban oak, spruce and chil which each contain a useful proportion of deodar, have been placed in a Selection Working Circle totalling 36,000 acres. Its rotation has been taken as 180 years, and the yield for deodar over 20″ diameter works out at 2·2 c.ft. per acre per annum. The markings are to be on a strict selection basis in order to safeguard the supply of immature deodar (24″ to 28″ diameter) which, in this circle, is barely sufficient to replace the mature crop.

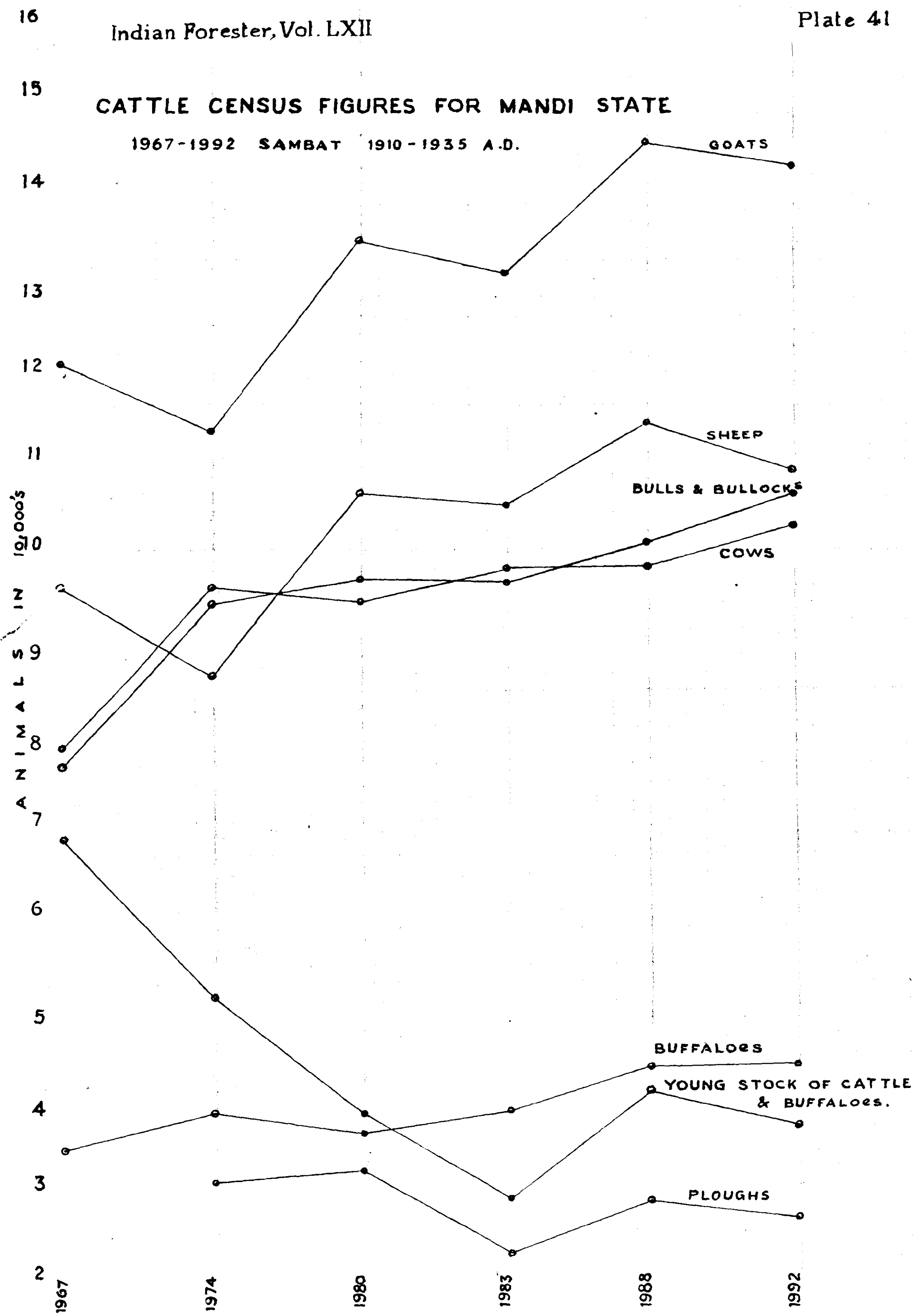
Chil and Spruce Prescriptions.—The chil forests 20 years ago were in a dreadful state, with only a scattered stand of the worst trees left after forest contractors had done their worst under a peculiar system of marking known as *hasabpasand*, or "come early and take your choice." Wright prescribed a complete rest from fellings, and the fire protection since 1921 has been so effective that huge areas are now full of sapling crops. Out of nearly 40,000 acres of chil, ¾ have now been classed as a Sales Felling Series and prescribed for the removal of the whole of the overwood wherever the young growth justifies it—the remaining ¼ is reserved for right holders. Strictly speaking, the adoption of regular working requires a known rotation age and a yield control aiming at sustained yield over a period longer than the 20 years of this plan. In this case, we have no reliable data for the rotation age, as the better part of the old crop disappeared in the traders' fellings, and it would not be at all accurate to base the present rate of growth of healthy young crops upon data obtained from the rubbish now forming the overwood. Nor need we have any volume control measures, for the real commercial yield disappeared in those early fellings, leaving us with a barely profitable remainder which there is no obligation to preserve. The prescription is, therefore, to develop and protect the young crop wherever it has become established.

The spruce and fir forests which contain some deodar have been provided for in the Selection Circle, and those devoid of deodar have been placed in the Protection Circle, for there is little chance of their being worked extensively with the fir market as poor as it is at present. Whatever outlet there may be is to be used in removing part of the over-mature stock, because it is only after this has been done that the question of regeneration can be effectively handled.

Live-stock Situation.—Mandi's total area of 1,125 square miles carries an average per square mile of 185 head of population and 478 head of local live-stock. When it is realised that large areas are unfit for any grazing at all; that the area under crops, about 235 square miles or 21 per cent. of the total, is not available for grazing; that over half of the total live-stock is of cattle and buffaloes, heavy

animals which consume a large quantity of fodder; and that huge flocks of foreign and itinerant Gaddis' sheep and goats are additional, it will be realised what an impossibly heavy drain is being placed upon the country. The demarcated forests escape at present more lightly than village land as they are generally farther from dwellings, and they can be protected to some extent by closure under the forest settlement. But the forests form such an integral part of the economic fabric of the community that it is not possible to treat them separately for long, and the gradual deterioration and destruction of other grazing grounds through misuse will inevitably bring a heavier burden of grazing upon the forests themselves. Census returns show a steady increase in live-stock in the last 25 years, but the last two census returns show very distinctly that the capacity of the country to carry live-stock has already passed a peak, and that the impoverishment which inevitably follows continued over-grazing has already set in (Plate 41, Recent Cattle Census figures). Since 1917 the number of milch cows and buffaloes has remained practically stationary and the number of ploughs in use has decreased, but the number of bullocks, sheep and goats has continued to increase. This is a sure sign that the better types of animals can no longer be maintained, as they are being ousted by less valuable animals which can subsist on poorer grazing. There are no early statistics for flocks in transit, but one may presume that itinerant buffalo grazing from outside has increased somewhat, and that the number of Gaddis' sheep and goats passing through the state has increased considerably, all tending to aggravate the local shortage of grazing.

Grazing Control.—Mandi State is exceptionally rich in grazing areas outside the demarcated forest, but the steady increase in the numbers of village herds and of the itinerant herds of Gujars' buffaloes and Gaddis' sheep and goats has now reached a point where restrictions must be enforced if serious erosion and desiccation of the entire land surface is to be prevented. The main principles for grazing control recognised in the settlement are: first, that *bartan* or rights are appendant to land paying revenue, *i.e.*, that residents must have first consideration; second, that *bartan* applies to the village for which


CATTLE CENSUS FIGURES FOR MANDI STATE
1967-1992 SAMBAT 1910-1935 A.D.
GOATS
SHEEP
BULLS & BULLOCKS
COWS
BUFFALOES
YOUNG STOCK OF CATTLE & BUFFALOES.
PLOUGHS
ANIMALS IN 10,000's
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1967
1974
1980
1983
1988
1992

it is recorded, *i.e.*, special grazing by herds from other villages should be allowed only where the resources justify it; and third, grazing should be limited to the reasonable agricultural and domestic needs of the villagers, *i.e.*, that surplus animals can be charged for and that types not strictly agriculturally necessary, such as Gujars' buffaloes, can be greatly reduced in numbers.

There are now three lines of action open, and they can all be made use of if a gradual but determined effort is made to reduce grazing to an incidence which will stop further deterioration—

(*i*) Demarcate all oak and scrub forest not immediately near villages, so that the movements of foreign herds can be controlled and closure to all grazing effected on a rotational basis. Mere demarcation without further action will, however, be useless.

(*ii*) Increase the grazing fees for Labanas' bullocks, Gujars' herds and Gaddis' *rahdari* or seasonal transit of flocks, and for "special" grazing by local herds, so that the seasonal concentrations of these animals is reduced. This policy has already been introduced on a small scale, but the increases in rate have not been sufficient to effect any noticeable change, and must be carried further. This system was for a time enforced in Kashmir, the rates having been increased on a rising scale by doubling them every second year both for "outside" grazing of local migratory flocks and for foreign flocks, until the grazing was brought to reasonable proportions. Foreign goats were prohibited altogether from entering Kashmir territory. (See *Indian Forester*, LVIII, 1932, page 1.)

(*iii*) Lay down a reasonable number of domestic animals per household, or per *bigha* or *ghumaon* of plough-land, and levy an increased tax on all animals above this number, making the tax relatively heavier for goats and for surplus bullocks than for other kinds of stock. As a reasonable basis of calculation the following is suggested: for each *ghumaon* (as much land as can be ploughed by a pair of bullocks in a day) allow a total of 30 live-stock units at the ordinary rate; a sheep to count as one unit; a goat 2 units; a milk cow or plough bullock 3 units; a buffalo 6 units. For example, a household with one *ghumaon* of land may keep either 6 sheep, 6 cows and bullocks, 1 buffalo;

or 9 goats, 4 cows and bullocks; or any other combination totalling not more than 30 units per *ghumaon*. Animals of less than one year to be exempt, but the rate for surplus animals over one year old to be 4 times the ordinary rate for goats and bullocks, twice the ordinary rate for other animals; the whole point being to bring pressure to bear in ousting useless animals.

Lopping Control.—Lopping also carries a special problem in forest management. The lopped spruce and oak woods fail to regenerate themselves, and the oak particularly is liable to be replaced by kail, the spruce only to a lesser extent. Kail is better than nothing, and provides at least a little cover for the soil, but the establishment of young kail thickets over large areas previously occupied by oak has already complicated the fire control, because the kail is so much more inflammable than the oak, and kail pole crops are liable to be completely destroyed by only one severe fire, leaving nothing whatever in their place. From all points of view, therefore, it would be sounder economy to preserve at least a mixture of oak amongst these new kail woods, thus making them more fire-proof and supplying a continuous source of fodder. The increased intensity of oak lopping is one of the most striking economic changes of the last 20 years, and in Kamlah, Seraj and Nachan very large areas of ban have already been killed by annual lopping, and much more is shortly doomed unless control is introduced immediately. This is simply because the people have deserted their old habit of a 3-year rotation for oak-lopping, which they themselves know to be the correct treatment, and against their own better judgment are now lopping all forests adjoining villages every year. A few ban and moru oak standing in their own fields are not lopped as heavily and bear testimony by their healthy appearance to the truth of this.

(*a*) *Lopping of Oak.*—In the Settlement Wright noted that there is no reason to place any restriction on lopping oak because "people seem to protect them and it is rare to see a tree killed by excessive lopping." This is no longer correct, because over very large areas of Seraj and Nachan the oaks are being exterminated by

heavy and continuous lopping. A right of user can be permanently exercised only if its existence is not threatened by over-use, so that the unrestricted right admitted in the settlement should be automatically cancelled. Protection is essential if the whole of the oak is not to be lost to the people as a valuable fodder resource from the areas where it is most needed. Enormous reserves of unlopped oak exist in certain parts such as Chachiot and the lower Uhl valley, but these are of no use whatever to villages many miles away whose own oaks have been exterminated. Restriction is in the interests of the people, not of the state nor of the forest department directly, but because it is one of the main economic resources of the villagers it must be placed on a basis of permanent yield, and this can only be accomplished by state control through the forest department.

(*b*) *Lopping of Fir.*—In the Settlement Wright further noted: "the spruce and fir are lopped, mostly for litter and manure, but as the majority of these forests are away from villages, the amount of damage is not very great." Here again the economic pressure has increased so much that this no longer holds. Spruce is now lopped everywhere near villages down to sapling size, and unless stricter control is enforced these trees will disappear from where they are most needed. Under the settlement it is legitimate to lop spruce and fir trees of over 2 *haths* (3 feet) in girth up to half their height, but this rule has not previously been enforced, as it was considered better to concentrate upon stopping the lopping of kail at the expense of these other species. Kail lopping has now been stopped, and it is essential to enforce the existing rule for spruce and fir.

Agricultural Situation as Affecting the Forest.—Most of the higher villages at 6,000 to 7,000 feet have originally been carved out of deodar and oak forest, leaving the pattern of field and forest inextricably mixed up (see Plate 36 in August issue). A surprisingly large area of deodar and kail forest occupies land which at some time in the past has been under fields, whose cultivation must have been abandoned owing to epidemics or more probably owing to the exhaustion of the soil by bad cultivation methods. It is quite wrong to imagine that

most of the farm land has been in continuous use for centuries; under existing farming methods most land is exhausted in a very few decades, and then reverts to scrub or forest. In the past fresh forest ground has been constantly taken up and cleared, so that the fertility of fresh soil has always contributed to farm crops, although the process has been so slow that the peasants themselves do not realise how transient their cultivation system really is.

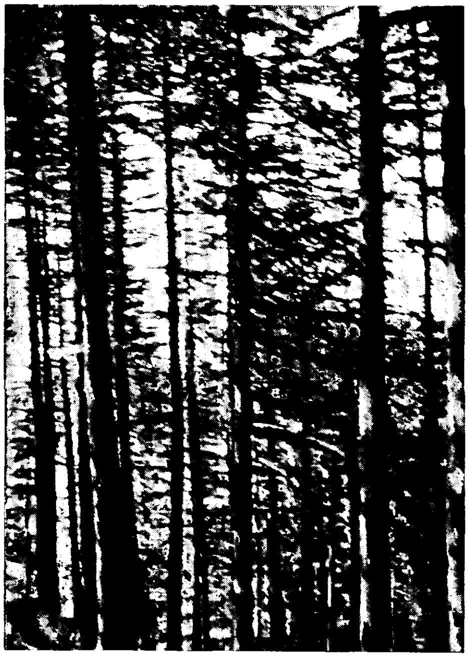
Now that demarcation of both field and forest has become more rigid, there is less opportunity for this gradual shifting of cultivation to continue, and it becomes more than ever necessary for the cultivator to improve his methods, so that soil loss is reduced to a minimum and soil fertility is maintained by proper manuring. The two main methods are—

(*a*) frequent terrace walls to keep the intervening fields flat or nearly flat to prevent heavy washing;

(*b*) a good manure supply, which can best be obtained by saving all refuse and rotting it in heaps, following the compost method so successfully introduced in Bangalore.

Previous to the 1917 settlement, the lopping of kail was a general custom, the twigs being lopped and used as litter for some months before being carried out to the fields as manure. This use of kail was gradually stopped and has now been almost entirely given up, but in many places more intensive lopping of spruce has taken its place. Lopping of oak also to some extent fulfils the same need, although of course most of the leaves and smaller twigs of the oak are used as fodder. The larger twigs of spruce and oak do not readily rot in the short time they are left on the cow-shed floor, and much of the loppings are wasted. A much more efficient use of the lopped material could be made if composting could be introduced; this would reduce the demands upon the forest and at the same time give better manurial value to the villagers.

The stoppage of lopping practices by frequent punishments and fines will merely make the forest department unpopular without helping the villagers out of their very real difficulties. Unless



SAMPLE PLOT NO. 1

SAMPLE PLOT NO. 3

TWO RUBBER NECK VIEWS OF WELL THINNED STANDS

CPT. 7 MODERATE QUALITY DEODAR. CPT. 6 HIGH QUALITY DEODAR
IN BOTH PHOTOS MORU OAK (QUERCUS DILATATA) IS SEEN ON THE LEFT

constructive improvement in their agricultural methods is brought about by the state authorities showing them how to improve productivity in the ways outlined above, increasing economic pressure will inevitably exhaust all the available lopping material, give rise to demands for disforestation to replace exhausted fields, and reduce the rôle of the forest officer to that of a harassed policeman, as has already happened in Rawalpindi.

THINNINGS IN SIMLA DIVISION

PART I.—SIMLA CATCHMENT FOREST

By N. G. Pring, I. F. S.

Many foresters will agree with Dr. Gorrie concerning his remarks on C grade thinning in his extremely interesting article entitled "Gradations in thinning intensity," *Indian Forester*, March 1936.

The writer's experience in the Catchment area where C grade thinnings on a 10-year cycle are prescribed for the Deodar Working Circle bears out Dr. Gorrie's remarks. On the other hand, practical foresters will agree with Mr. Laurie that thinning grade definition should be used as a guide and that it would be impracticable to use the ratio of basal area crop diameter as a check on markings over large areas. Most of our coniferous woods, except chir pine, are mixed, and retention of the desired mixture is much more important than an exact spacing; also the vast majority of forests, other than plantations, are uneven aged and show little uniformity as regards quality. Other considerations, such as stocking, irregularity of the ground, crown development, the difficulty of selecting true sample areas, disease, etc., make the accurate application of check by sample plots practically impossible in most cases. However, S. Arjan Singh, Forest Ranger in charge of the Simla municipal forests, who has experience of research work, and the writer, have endeavoured to apply Champion and Mahendru's Multiple Yield Table for Deodar in certain compartments recently thinned where we believe that application gives tolerably accurate results. B. Sant Ram,

Extra Assistant Conservator of Forests, also kindly helped with the laying out and checking of two plots and also checked the calculations for all plots. The forests of the Catchment area in which endeavour was made to find reliable sample plots were as follows—

Compt. 2 (*a*), the higher portion of which includes a large belt of nearly pure low quality deodar forest with a little mohru oak and occasional spruce and kail. Over most of the area, including sample plots Nos. 1 and 2, a C grade thinning was attempted. The thinning was criticized as being rather light; it was however definitely heavier than the C grade thinning illustrated on Plate 8 of Dr. Gorrie's article. A much heavier grade of thinning made over a small section was preferred ; no sample plot can now be formed in this area because wind, following heavy wet snow in February 1935, felled 45 trees over approximately 6 acres. Most damage occurred in nallahs, some of the heavily-lopped kail forests of neighbouring States were also badly knocked about and the writer remembers similar damage in a high quality heavily-thinned chir pine sample plot of the Murree hill forests.

Excluding this heavily marked section, the intensity of marking was considered too light in Compt. 2 (*a*), and it was, therefore, decided to take a C grade prescription to mean that the intensity of marking should nowhere be less than C grade, thus getting over the difficulty of what to do where it is either a case of leaving a group congested or of marking a heavier grade of thinning than that prescribed. Therefore, endeavour was made to mark a C/D grade of thinning in Compt. 7 also of the Deodar Working Circle. The result gives the best impression of all of these recent series of thinnings, which may be due to the fact that the average site of quality is much higher than that of Compt. 2 (*a*). There is an appreciable amount of oak mixed with the deodar in I class localities. The crop also contains some spruce and kail. Unfortunately it is found impossible to lay out sample plots in Compt. 7, but the marking is much akin to that in Compt. 6 felled in 1935, being perhaps slightly lighter and rather more regular. The major portion of Compt. 6

includes predominantly deodar forest mixed with mohru oak and a little kail and spruce. As in the case of Compts. 2 (*a*) and 7, thinnings and improvement fellings were made during the War, but they appear to have operated more heavily in Compt. 6. Two sample plots were selected in deodar woods, but it was impossible to find sample areas without some mohru oak.

Attempts to lay out sample plots in Compts. 1 (*a*), 7, 19, 20, 21 and 22 were precluded by the unevenness of the growth, irregularity of spacing, mixtures, under-stocking, etc. Therefore, from eight compartments of the Deodar Working Circle, each averaging 90 acres, the use of the ratio of basal area/crop diameter could be attempted only in two. In the following plots all trees are deodar unless otherwise stated :

Compt. 2 (*a*). *Sample Plot No.* 1=0·25 *acre.*

			Comparison with the Multiple Yield Tables.
Crop age	..	95	Table 18, E grade is the nearest.
Diameter	..	12·2″	
Average height	..	77′	In Table 31 it also tallies with
Site quality	..	3	an E grade.
Basal area per acre	..	158	Table 32 shows a correspondence
No. of trees per acre	..	196	with D/E grade.
Average spacing	..	15′	

Does not give the appearance of being anything like so heavy, and has been criticized as rather light. (See illustration.)

Compt. 2 (*a*). *Sample Plot No.* 2=0·16 *acre.*

			Comparison with the Multiple Yield Tables.
Crop age	..	89	
Diameter	..	9·5″	From Tables 19 and 20 the
Average height	..	71′	grade works out as D/C.
Site quality	..	3	
Basal area per acre	..	180	In Table 31 it tallies with a
No. of trees per acre	..	362	D grade thinning.
Average spacing	..	11′	Table 32 points to a D/C grade.

Gives the appearance of being the same intensity as plot 1.

Compt. 6. *Sample Plot No.* 3=0·25 *acre.*

			Comparison with the Multiple Yield Tables.
Crop age	..	89	This does not correspond closely with any table, but the nearest is No. 11 which points to a D grade thinning.
Top	..	99	
Average diameter	..	11·8″	
Top height	..	106′	
Average height	..	90′	Table 31 shows it as E grade.
Site quality	..	2	From Table 32 it tallies with E/D
Basal area per acre	..	157	
No. of trees per acre including 8 oak among the canopy	..	192	
Average spacing	..	15″	

Therefore it may be taken as D/E grade thinning, which appears lighter owing to an average of about 20 small oak per acre among the under storey—(See illustration).

Compt. 6. *Sample Plot No.* 4=0·25 *acre.*

Two sample trees were felled but the plot was found to be too irregular to permit of accurate height, age and quality assessment.

Average diameter	..	11·4″	Table 31 shows that it approaches an E grade thinning, while in Table 32 it lies half way between D grade and D/E grade therefore it may be taken as a D/E grade felling.
No. of trees per acre including 28 oak among the canopy	..	228	
Average spacing	..	13·9′	

All measurements taken were of course horizontal measurements. In sample plot 4 having a slope of about 30 degrees, the horizontally measured plot included 9 more trees than the same plot measured along the surface or an additional 36 trees per acre. Area and tree measurements of all plots were rechecked. The present stocking is at any rate so nearly complete as to make no difference to the thinning grades shown above. The past stocking is quite another matter, and the discrepancy between sample plots Nos. 1 and 2, which both have the appearance of a very similar and rather light marking,

may be due to the fact that the trees of plot No. 1 were exceptionally widely spaced in youth. The Multiple Yield Tables apply presumably to densely naturally regenerated deodar woods, because a deodar plantation with a spacement of $10' \times 6'$ gives a much smaller number of stems per acre than the numbers given in Table 31.

Admitting the general *impracticability of using the Multiple* Yield Tables for checking thinning markings over large areas, the above results bear out Dr. Gorrie's remarks concerning C grade markings, and prove definitely that a heavier grade of marking is desirable wherever it can safely be applied. If further proof of Dr. Gorrie's contention is needed it is afforded by a 4′ stick method of cleaning successfully used in Kulu and other divisions. Assuming a crop to be as much as 20 years old and the resulting average spacing between stems about six feet, on a site quality 2 locality the result will be plus E grade thinning!

PART II—OTHER FORESTS

There are 26 States in Simla Forest Division of which 17 are provided with working plans or schemes ; some of these have several working circles for coniferous forests and all of them prescribe thinnings. The thinning cycles vary from 5 to 15 years, the vast majority being for 10 years. Thinning grades are mentioned in all the more recent plans, nearly all of which prescribe a C grade felling, while one plan prescribes a moderate, ordinary thinning, B grade (F. R. I.) for middle-age pole woods ; the writers generally prescribe that thinnings be carried out in accordance with the Punjab Forest Leaflet No. 1 (Thinnings).

Three of the four Cantonment forests with working schemes prescribe a C grade felling for predominantly chir pine forest, while the latest revised scheme rules that thinnings should not be lighter than C grade or heavier than D grade. The P. F. S. trained foresters can mark thinnings suitable to the crop, and although the result is sometimes a D grade or even heavier, there is not the slightest doubt that the forests have been well thinned, and the improvement is most marked in those forests where thinnings have operated regularly.

Many of the compartments or sub-compartments contain so great a variety of woodland that several grades of marking are desirable ; it certainly seems undesirable to prescribe any single grade of marking for a whole working circle. In predominantly pine or deodar forests the average marking probably approximates to a D grade marking in regular stands ; however, the risk of snow break, blanks between groups, disease, the necessity of favouring the more valuable species, and the desirability of retaining a mixture, enforce various grades of marking in most of the forests. Thinnings in well-managed States of Simla Division are based on those defined in Punjab Forest Leaflet No. 1-A "Practical Hints on Thinnings in Coniferous Woods" (Glover). Mr. Glover gives a C grade thinning as that to be employed in the Eastern Circle, but he also likens the operation to that formerly defined as a light crown thinning, in which, however, suppressed trees are ordinarily cut in order to minimise the effects of fire. Mr. Glover also points out that later on a temporary break in the canopy is inevitable and gives a very useful espacement guide which results in a D grade thinning in favourable localities.

Snow damage is a risk that cannot be ignored in Simla Division where many of the crops are the result of past selection fellings when cleanings and early thinnings were neglected. There is also a very large area of mixed forest in which deodar, kail and occasional broad-leaved trees tend to form more or less an upper storey, while spruce, silver fir, oak and other broad-leaved species tend to form a lower storey. Naturally in such cases thinning consists of two operations, a heavier grade of thinning in favour of best stems among the more valuable light demanders, and a lighter thinning among the shade bearers. An E grade thinning everywhere would certainly have resulted in unnecessary snow damage. Many of our forests now require a very heavy thinning in favour of selected stems, notably all P. B. II woods, some of the deodar woods of Keonthal State and kail woods of Koti State. Fortunately the marking officers have stretched the grade to suit the obvious need of the crop and in such cases we are grateful to Ralph C. Hawley for the

plates depicting a C grade and light crown thinning ! All of which points to the necessity of something more elastic than the present usual prescription of the single grade of thinning, generally C for a whole working circle consisting of mixed and rather irregular woods. Perhaps it would be best for the working plan officer to suggest a grade or grades he considers most suitable for each compartment.

It certainly looks as if heavier thinnings than those practised hitherto could operate provided forests were well tended from the beginning. If we can operate the 4′ stick method and follow it up by E grade thinning at increasingly longer intervals in coniferous crops without growing knotty or snow-damaged trees, it will be greatly to our advantage.

In conclusion the writer feels that tribute is due to those subordinates by whom most of our thinnings have been marked. In some divisions of the Eastern Circle where beats are extensive and where there is a large additional area of undemarcated forest, a proportion of the markings have necessarily been entrusted to specially selected forest guards, with excellent results. Marksmen, gun-layers and rough-riders, who have passed a special test, are entitled to a special badge. One feels that forest guards who show themselves efficient in the art of thinning, on which depends the welfare of our forests, might also be entitled to wear a distinctive proficiency badge.

SAL NATURAL REGENERATION IN ASSAM

By A. J. W. Milroy, I.F.S.

All forest officers who have had anything to do with sal must have read with great interest the admirable article by Mr. Smythies on "Seedling Regeneration in B-3 Sal," published in the April number of the *Indian Forester*. The question that he raises as to whether grazing is important or not is now under investigation in Kamrup where, as recorded by the Inspector-General, the principal difficulties in the way of naturally regenerating sal appear to have been surmounted,

The results recorded by Mr. Smythies in the U. P. deal only with the successful treatment of already existing whippy shoots, but in Kamrup we had to start with nothing at all in the way of regeneration, for prior to 1916 the Plains Reserves were fire-protected with reasonable success, and no seedlings could be found except on fire-lines and by road-sides. Burning was commenced in 1916, being a difficult process for some years, but nothing happened until 1926 when large tracts in the forest became carpeted with seedlings after a particularly good seed year ; ever since then seedlings have been common nearly everywhere, and in most places so profuse that junior officers find it difficult to envisage a state of affairs when there were absolutely none.

Burning was started in Goalpara at some later date and with the same result that seedlings are now common in many places, though formerly almost entirely absent.

Our experience has been, then, that burning, whatever its exact effect on the soil may be, is *the* essential preliminary in Assam for the production of surface conditions favourable for the germination of sal seed, the only discoverable substitute for it being cultivation with the hoe.

A subsidiary local effect of burning is that it encourages stool shoots to be thrown out even from quite large stumps, which appear to be stimulated in a way that they were not under fire-protection.

Contrary to our then expectations burning alone did not establish the seedlings, which tended to disappear except where gaps in the canopy had encouraged thatch to spring up, and so in our anxiety to reproduce the grassy "Boko conditions" we were compelled to adopt the same two measures that Mr. Smythies found so necessary, namely, the reduction of the overhead canopy and the lessening, in Kamrup by fire, of weed competition.

Around Boko there are large tracts of thatch land full of sal fleshy shoots everywhere within the reach of mother-trees, reservation followed by fire-protection being all that is required to get up the sal, which otherwise is burnt back year after year until some accident, such as a wet year, gives it a chance to make a little progress.

Champion has recorded his opinion that it would probably be possible to regenerate a sal forest by reproducing Boko conditions, but that the process might take too long to be practicable, judging by the ages of the root-stocks that he examined. It happens, however, that it all depends at Boko where one looks, and examination of the root-stocks to leeward of a mother-tree only old enough to be beginning to produce seed will show that they are all of recent origin.

Having achieved whippy shoots in thatch all that should have been further required, theoretically, was the enlargement of the groups and the continuation of the annual burnings until there were sufficiently extensive contiguous areas containing fleshy shoots, developed as at Boko from the whippy shoots, to make fire-protection worth while, but two difficulties arose, one being the luxuriant growth of thatch that was inclined to follow very drastic enlargement of the groups or strips, and the other being the wholesale invasion by *Eupatorium* of many of the areas in P. B. I.

Vigorous sal regeneration is found in Boko flourishing under the heaviest of thatch, but this must clearly have taken a long time to become established, as the mortality amongst seedlings from the fiercer grass fires is very high, and retrogression rather than progress has followed wherever we have tried to go too fast with the removal of the canopy in grassy compartments.

Such sal seed as reaches the ground under *Eupatorium* germinates freely enough, and the seedlings may persist for 2 years or longer though without any hope of being able to force their way up, but luckily this weed is easy to pull up in the spring, and by doing this the seedlings are encouraged to establish themselves as whippy shoots.

Doubts have been expressed about the possibility of persuading the established whippy shoots to proceed on and become fleshy, but by marking cautiously in extending those groups where the ground-cover is principally thatch, and by a rains uprooting of the *Eupatorium* progress, which was formerly slow, has become normal, and there seems to be absolutely no reason now why it should not continue to be so. There has admittedly been some stagnation on the part

of the whippy shoots, but the secret with them seems to be to give them a little help during the rains against the competing weeds.

It has been suggested that the absence of grazing may possibly be responsible for the failure to obtain natural regeneration on a large scale in Goalpara, but it is difficult to fit this in with the facts.

The same number of cattle from the same villages have been grazing in the Kamrup Sal Reserves since the Year One, and yet no seedlings were observed before 1926: grazing cannot, therefore, be a factor in obtaining seedlings in unburnt forest, and as the seedlings since 1926 have been just as profuse where there has never been any grazing, it is impossible to argue that the presence or absence of cattle has any effect at all upon the initial stage in sal natural regeneration. As regards the second stage, the establishment of whippy shoots from the seedlings, most of this has occurred in Boko in the absence of grazing, but elsewhere there are indications in certain places that the process may be expedited where there has been light grazing in the vicinity of villages, just sufficient to have some depressing effect upon the exuberance of the grass and weeds. As against this, equally good results have been obtained in areas not visited by cattle, and no special benefit has been noticed in the locality where grazing (light, not concentrated) has been encouraged for years for the sake of milk supply to the subordinates.

Concentrated grazing at any rate is definitely harmful, and all that can be said at present about light, casual grazing is that it may have some beneficial effect in mechanically serving to keep down grass and weeds that might otherwise smother seedlings.

Cattle have later to be excluded by means of wire fencing, if the whippy shoots are to develop into fleshy shoots, so the presence of cattle is not entirely welcome in our Assam sal forests, where there is no deer problem to make fencing otherwise necessary.

Goalpara certainly looks a poor show after Kamrup, but the indications that natural regeneration will be successfully achieved are very much more in evidence than was the case in Kamrup some years back. Burning and other operations were started much later in Goalpara, but the main obstacle here has been the fact that until

last July a single Divisional Forest Officer was expected to look after 900 square miles of reserved forest containing a departmental tramway of 45 miles, and to arrange for the administration of forest villages containing 5,471 adult male labourers, with everything else on the same scale. Now that this unwieldy division has been split up into two, the Divisional Forest Officers will have time to get down to it and put in some concentrated effort. Good seed years, fires, grass, cattle maybe, and so on, are all necessary if natural regeneration of sal is to be achieved, but they are wasted, we have found, unless the officer responsible is in a position to be able to stop in his forest and keep himself familiar at all seasons of the years with the constantly changing situation : he requires some security of tenure, if he is to see the matter through, and a tent is in this business very much mightier as regards obtaining results than any car. The proof that this is so is on the ground, for Boko conditions prevail throughout the zemindar's forests lying to the south of the Goalpara Reserved Forests.

Note by H. G. Champion, Silviculturist, F. R. I., Dehra Dun.

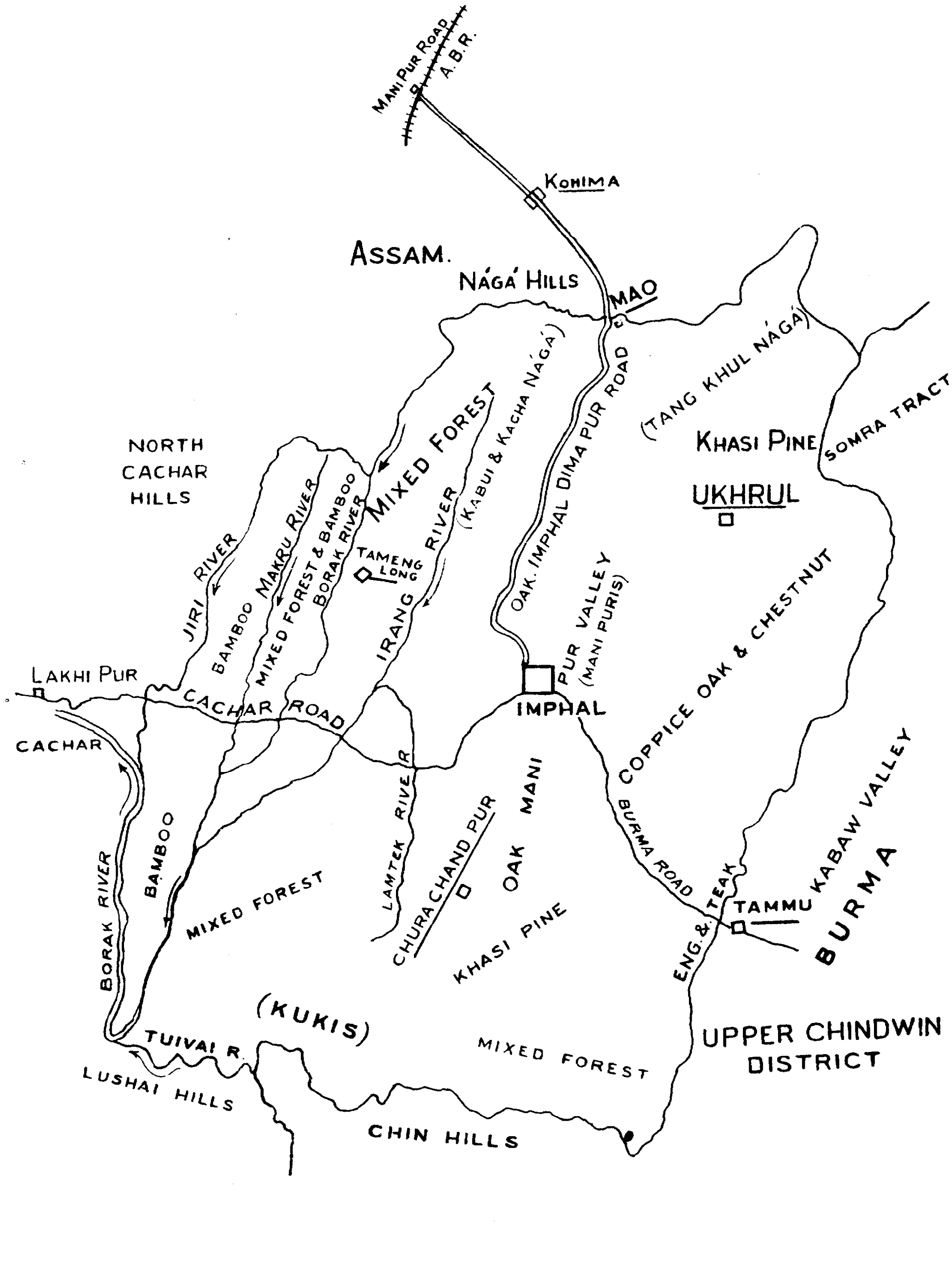
Congratulations are due to those who are responsible for the important advance in our knowledge of sal regeneration methods in Assam. When the "Sal Committee" visited Kamrup in 1932—Mr. Milroy being most unfortunately absent on leave—it seemed to us quite certain, from what we saw and the written records of specified "foci," that regeneration was going back on them. Sound forest sense was shewn by the then D. F. O., Mr. Simmons, when he stressed this, got fellings temporarily restricted, and commenced investigations on methods of assisting the retrograding regeneration and completing it. That only one or two years have elapsed before a solution can confidently be claimed, in no way detracts from the soundness of calling a check on further fellings in 1932; experience with sal elsewhere clearly shews that it might have taken 10 years or more to find the way out, and a serious position would have arisen—actually was arising.

I think it likely that some readers may still be misled by some of the references to "Boko conditions." The "committee" examined root stocks near seed trees of various sizes, and found them of all ages from the last seed-year upwards. They came to the conclusion, that in the heavy thatch associated with full overhead light over large areas, the rate of addition of new stocks was too slow to be acceptable as part of a system of management, and though apparently charging the "committee" with drawing unjustified conclusions from superficial observation, Mr. Milroy also now says that under these conditions, retrogression rather than progress occurs. That issue is now dodged—and luckily it can be—by rains weeding, and all honour to those who first thought of doing it!

All interested in sal regeneration would, I am sure, like myself, like to have more data as to the time factors involved, as it was on this point that the Kamrup working plan slipped up, and in the United Provinces also there is still a gap in our knowledge, *viz.*, the time required to get from a seed-year to whippy shoots of a size which can be persuaded to send up permanent stems, *i.e.*, to pass on to the established stage. One might hope, that under the more favourable Kamrup conditions, there need be no appreciable pause, and it is to be hoped that steps are being taken to ascertain this under acceptable experimental conditions duly recorded.

I venture to repeat the "committee's" suggestion that Assam workers could make their valuable contributions to the exciting history of the full solution of the sal regeneration problem clearer to others if they would standardise and define the terms they use—"established," "thatch," etc., as it happens that their usage differs from that of the majority.

MANI PUR STATE



MANIPUR FORESTS

By D. C. Kaith, B.Sc. (Edin.)
Chief Forest Officer, Bijni Raj Court of Wards Estate, Abhayapuri, Assam.

Readers of the *Indian Forester* will be surprised to know that Manipur State, though about 13th in area amongst the Indian States, has no proper forest department, no forest policy, and no trained forest staff to look after its forests.

With a view to developing the State forests on sound lines, the Manipur State Durbar, under the Presidentship of Captain C. W. L. Harvey of the Political Department, appointed the writer of this to report on all the State forests and submit proposals for their better management during the cold weather of 1932-33.

The State is situated between Assam and Burma and the only road from British India to Burma passes through Manipur. It is bounded on the north by the Naga Hills (Assam), on the east by Somra tract and Upper Chindwin district (Burma), on the south by the Chin Hills (Burma) and Lushai Hills (Assam), and on the west by Cachar and North Cachar Hills (Assam). The nearest points of the Assam and Surma valleys of Assam and of the Kabaw valley of Burma are, respectively, some 55, 50 and 25 miles distant from the Manipur valley as the crow flies. The area of the State is 8,638 square miles, some 750 of which form the central valley of Manipur which is about 2,600 feet above sea-level with drainage from north to south, while the remaining area of over 7,888 square miles consists of mountainous and hilly country rising up to 10,000 feet above sea-level. The Manipur valley is inhabited by Manipuris who are orthodox Hindus by religion, and the hills are occupied by Nagas, Kukis and other hill tribes who have tribal religions of their own and are taking to Christianity too. The principal rivers in the State are the Imphal (Manipur) and the Barak river, the former with its tributaries draining the Manipur valley, the hills immediately surrounding it and the southern hills, and the latter draining the northern and the western hills. The Imphal river flows through the Chin Hills and the Kale valley into the Chindwin river of Burma and the Barak river flows

through Cachar and Surma valley into the lower Brahamaputra. The valley of Manipur is dotted with lakes and marshes, many of which dry up in the cold weather, but there is a number of large lakes which retain water throughout the year. The largest being the Loktak which is some 8 miles in length, 5 miles in breadth after the rainy season and attracts the game birds from as far as Siberia. Loktak is probably one of the finest duck shooting lakes in India. I would like lovers of game to refer to articles on "Game birds and animals of the State with notes on their numbers, migration and habits" in the *Journal of Bombay Natural History Society*, Vol. XXXVI, No. 2, by J. C. Higgins,* I.C.S., who served as Political Agent and President in Manipur for 18 years. The capital of the State is Imphal, 134 miles from Manipur road railway station on the A. B. Railway and this journey is done in a lorry in one day—the road passing through Naga Hills, a very picturesque country indeed.

The ruler of the State and owner of the forests is His Highness the Maharaja of Manipur and the administration is carried out through the State Durbar guided by the President, who is generally a borrowed officer from Assam, and the Political Agent in Manipur.

The forests are scattered all over the State situated between latitude 24°—26° and longitude 93°—94° and can be separated into 4 sharp divisions, namely—

(1) Barak drainage forests consisting of dense mixed forest with large tracts of bamboos.

(2) Manipur valley forest consisting of oak and chestnut.

(3) North-east forests of Khasi pine and oak.

(4) Burma border forests of *eng* and teak.

Barak Drainage Forests.—These forests are most important and are at present being worked by the State and are being managed by the Assam Forest Department. This management by the Cachar Divisional Forest Officer is to collect forest revenue at Lakhipur forest revenue station on forest produce brought down by enterprising timber traders of Cachar.

* The writer is indebted to the above officer for going through this article and correcting it.

The forests are situated in Western Manipur hills and are confined to narrow belts varying in width from 0 to 3 miles along Barak river and its tributaries such as Jiri, Tuivai, Irang, Leimatak and Makru and their side streams. The country is very hilly and cut up by rivers which run in parallel valleys of varying width and gradient. In places river banks are so steep and obstructed by large boulders that it is difficult to move along rivers. Sandstone and shale are the underlying rocks in these hills. Soil is clay loam and deep in places, but shallow in exposed situations.

Heavy rainfall is the main feature of the climate of these hills. Rains start in April and go on till September and October, June and July are the rainiest months of the year. Summers are hot, but it is quite pleasant during the winter. River sides are unhealthy and malarious and forests are covered with leeches during the rains. Record of rainfall at Tamenglong is of great interest—

Year.			Annual rainfall, inches.
1928	..	..	145·3
1929	..	..	150·24
1930	..	..	134·64
1931	..	..	138·78
1932	..	..	164·84

In 1929 there were serious floods in the Surma valley of Assam, causes of which have been given further on.

Composition and Condition of the Forests.—The area of the country drained by the Barak and its tributaries is about 2,250 square miles, of which tree forest occupies about 530 square miles, bamboos (*Melocanna bambusoides*) 1,000 square miles, and the rest constitute scrub jungle and *jhum* lands. Forests are called after the names of the rivers on which they are situated and short descriptions of each are given below.

Jiri River Forests.—Forest along the river bank is of very poor quality and inferior species like *Isonandra polyantha*, *Bischofia javanica*, *Artocarpus hirsuta*, *Premna bengalensis*, *Canarium reziniferum*, *Cynometra polyandra*, *Ficus* sp., *Mangifera indica*, *Terminalia*

citrina, *Kayea floribunda*, *Anthocephalus cadamba*, *Diosphyros* sp., *Litsea* sp., *Sapium baccatum* predominate. Due to the forests being easily accessible and being continuously worked, valuable species have disappeared. In the upper reaches and away from the river banks a better type of forest in which valuable species like *Cinnamomum cecidodaphne*, *Alseodaphne owdenii*, *Machilus villosa*, *Cedrela toona*, *Amoora rohituka*, *Artocarpus chaplasha*, *Michelia montana*, etc. predominate is to be seen. There are large patches of pure *muli* bamboos (*Melocanna bambusoides*) intermixed with tree forest.

Barak River (Main) Forests.—Starting from Jiri mukh towards Tipai mukh along Barak river which forms the boundary between Manipur and Lushai Hills and Cachar, one sees land being cleared of forest for cultivation and *tillas* being *jhumed*. Trees over 6 feet in girth are rare and valuable species have disappeared due to the removal of mother trees and immature growing stock. There are large tracts of *muli* bamboos. In the upper reaches of Barak valuable trees of large dimensions were measured and there is nothing on record to show that forests in upper reaches were ever exploited. The growing stock consists of the same species as found in Jiri forests.

Irang River Forests.—These forests are very rich in softwoods. In the upper reaches virgin forests are met with. As we go towards the Manipur valley *muli* bamboos disappear gradually giving place to coppice forests of oak and chestnut.

The following species are found in abundance—

Bombax malabaricum and *B. insigne*, *Trewia nudiflora*, *Tetrameles nudiflora*, *Cedrela toona*, *Albizzia lucida*, *Gmelina arborea*, *Duabanga sonneratioides*, *Albizzia lebbek*, *Lagerstroemia parviflora*, *Bursera serrata*, *Anthocephalus cadamba*, *Dillenia pentagyna*, *Terminalia myriocarpa*. No trees of *Mesua ferrea*, *Isonandra polyantha*, *Kayea floribunda* were noticed. On high peaks *Phoebe hainesiana*, *Machilus*, *Cinnamomum* sp., *Michelias* and *Eugenias*, attain large dimensions. There are large supplies of canes available.

Makru River Forests.—On the right bank there is a low and hot range and hill-tribes have not settled and *jhumed* these forests. There

are compact blocks of tree forest with *Mesua ferrea*, *Kayea floribunda*, *Isonandra polyantha* as predominating species. There are large supplies of *Artocarpus chaplasha* available within easy reach. Unfortunately every year *jhums* are being extended towards the river, thus making forest working difficult and uneconomical.

Tuivai River Forests.—The forests on the right bank of Tuivai river only belong to the State as the river forms the boundary on the south between Manipur, Chin Hills of Burma and Lushai Hills of Assam. Forests have been spoiled by shifting cultivation. Only on rocky places, where it is not possible to *jhum*, tree forest remains.

PAST HISTORY

Some centuries ago all the Barak drainage was covered with virgin forests ; then came the Nágás and formed villages on healthy hilltops. These people live on shifting cultivation and have the habit of forming permanent villages which are well fortified against enemies. They possess permanent *jhum* lands which are cultivated at 7 or 8 years rotation. Where there is an old tree forest near about Nágá villages that land is not fit for *jhuming*. These conditions are met with in the north-west area above Manipur-Cachar road. Later on, the Kukis came from Lushai Hills and drove the Nágás towards the north and themselves settled in south-west Chura Chandpur area, really the Nágá country. The Kukis were not contented with old *jhum* lands cultivated by the Nágás as these were coppice forests and easy to cut, with the possibility of deterioration of muscle strength ; the old men insisted on felling good tree jungle to maintain their strength to repel the attacks of any aggressor. This custom of destroying tree jungle is still prevalent amongst the Kukis who, it may be said, are the greatest enemies of forests. Timber-producing areas are on the decrease. Whenever bamboos flower, *jhum* lands become bamboo lands. During the period of prosperity which followed on British occupation of Eastern Bengal and Assam the demand for timber began to increase and Manipur forests attracted timber traders from the Surma valley of Assam.

Arrangements were made with the Government of India to hand over these forests to the Assam Forest Department in 1898 on the following terms—

(1) that working of Manipur forests to be in charge of the Divisional Forest Officer, Cachar ;

(2) royalty and import duty combined to be charged on forest produce coming into Cachar from Manipur at the rates levied on forest produce from Government forests in Cachar;

(3) that the gross income be divided between Government and the State in the proportion of 25 per cent. to the former and 75 per cent. to the latter.

In sanctioning this arrangement Government stipulated that the charges for revenue collection were only to be borne by the Forest Department, the local Government being explained that Manipur forests are to be worked on the same system as unclassed State forests in the Surma valley of Assam. All expenditure by Government on improvement and conservancy having been prohibited it was evidently not desired that the Government Forest Department should undertake any works of improvement other than revenue collection. It is clear that neither the Conservator of Forests of Assam, nor the D. F. O., Cachar, were empowered to see that these forests were properly conserved. The D. F. O. Cachar's responsibility begins and ends with the collection of royalty on all forest produce brought down from Manipur by timber traders, 75 per cent. of the dues so collected being refunded to the State and 25 per cent. going to swell the forest revenue of Cachar division.

Timber traders start exploitation in their best interests. Minimum girth limit fixed was 4′-6″ at breast height, but they cut down all the accessible undersized timber that could be sold and escape through Lakhipur with the plea that they have brought down undersized timber from the *jhums* of hill tribes in Manipur. They work year in and year out in the same forest, with the result that there is no regeneration of good species, all mother trees were removed long ago. They fell more trees than they require, leave what they cannot extract, and are not always careful in rafting their logs, many going

adrift before they reach Lakhipur revenue station where royalty is assessed. There is no resident staff to look after the forests.

Marketable Products.—Timber in the log is the major produce exploited from these forests. There are unlimited supplies of *muli* bamboo and canes available. *Chaulmoogra*, tea seed, and *agar* are also found.

Centres of Consumption.—Most of the Manipur forest produce is exported to Assam and Eastern Bengal.

Lines of Export.—Main lines of export are Barak river and its tributaries. Bamboos for paper pulp are carried by rail to Calcutta paper mills. There are lots of rocks called " Hatias " obstructing river channels and are the cause of breakdown of bamboo "bungas" carrying heavy non-floatable logs with the result that logs get stranded and go waste.

Labour Supply and Rations.—Every year in the working season (March to September, the worst months of the year for forest exploitation in these parts) hundreds of forest workers come to these forests from Surma valley and go back to their homes after timber operations are over. Local population such as the Kukis and Nágás have taken little or no interest so far in forest work. If they do a bit of work for timber contractors they are cheated by being made less payment or no payment at all. The best months of the year for forest exploitation are from November to March ; it is in these months in which Cachar labour generally wants to go home for the paddy harvest and such a gorgeous time is lost and the output considerably lessened. Local population will form excellent labour if properly and sympathetically handled. Hillmen are of very independent nature ; if they don't want to work they just walk away. What is required is a sympathetic forest officer who would take keen interest in the uplift of the hill-tribes.

Practically speaking, rations for all outside labour are not available in Manipur Hills. Hill-tribes grow rice just sufficient for their yearly requirements. Contractors have to bring rice, salt, etc., for their labour, and elephants all the way from Cachar to these remote forests. Boats, elephants and men are used for carrying rations.

Mode of Extraction.—Logs are hauled by elephants to the nearest floatable stream and there non-buoyant logs are tied with bamboo "bungas" and kept ready for the flood to carry them down to Lakhipur depôt where these are caught and made into big rafts which are then sent to various markets down the Barak river.

Some of the trees with names in Bengali, B., Manipuri, M.; Kuki, K.; and Kabui-Nágá, Kb., are given below—

Albizzia lebbek, *moroi* or *siris*, B.; *khok*, M.; *vangsip*, K.; *Alphonsea ventricosa*, *paknakola*, B.; *seiltuoi*, K.; *Alseodaphne owdenii*, *til sundi*, B.; *sakhi pelhnam*, K.; *Amoora rohituka*, *Amoora spectabilis*, *rata*, B.; *heirang khoi*, M.; *sahata*, K.; *agau*, Kab.; *Artocarpus chaplasha*. *chaplash*, Trade name; *cham*. B.; *heirukok tong*, M.; *tatpong*, K.; *pram*, Kab.; *Artocarpus hirsuta*, *dewa*, B.; *heiru kok thong*, M.; *A. integrifolia*, jack-fruit tree, *kathal* B.; *theibong*, M.; *lamkhong*, K.; *Aquilaria agallocha*, agar wood, *agar* B.; *laphthro*, M.; *thingrei*, K.; *gum*, Kab.

Bauhinia variegata, *kanchan*, B.; *chingau*, M.; *viabe*, K. *Bischopia javanica*, *joki* or *urium*, B.; *uthom narobi* or *theichak*, M.; *khongthli*, K.; *inda*, Kab. *B. insigne*, *dumbol*, B.; *tera*, M.; *inpang* K. *Bombax malabaricum*, *semul*, B.; *tera*, M.; *kamuiorta* Kab.; *phung chong*, K.

Callophyllum inophyllum, *tailo*, B.; *saleiman*, M.; *ralngam khoifok*, K.

Camellia thea, *cha*, B.; *cha*, M.; *thingpi*, K. *Cassia fistula*, *sonaru*, B.; *chahui*, M. *Castnopsis hystrix*, *Castnopsis tribuloides*, *Castnopsis indica*, *khemta hingri*, B.; *sahi or thangji*, M.; *sic thing*, K.

Cedrella toona, *toon* or *poma*, B.; *tairel* or *tairen*, M.; *tei*, K.; *inthang*, Kab.

Chukrassia tabularis, *khemta chakrasi* or *boga poma*, B.; *thing saphou*, K. *Cinnamomum cecidodaphne*, *gundroi*, B.; *tumitla*, M.; *vommim*, K. *Cordia odoratissima*, *mohidal*, B.; *lamuk*, M.; *hmukpui*, K. *Crataeva religiosa*, *borum*,

B.; *loiyumba lei*, M.; *Cynometra polyandra ping*, B.; *thing chang ling*, K.; *nanap*, M.

Dillenia indica, *chalta*, B.; *heigri* M.; *korthingdeng* K. *Duabanga sonneratoides*, *ramdala*, B.; *tan*, M.; *zong*, K.; *ngam sang*, Kab.

Eugenia jambolana and species.—*jam*, B.; *jam* or *mui*, M.; *longsui*, Kab.; *mui*, K.

Ficus bengalensis, *bar* or *bot*, B.; *khongnang tarung*, M. *F. religiosa*, *aswat*, B.; *khongnang* M.

Gmelina arborea, *gamari*, B.; *wang*, M.; *invong*, K. *Gynocardia odorata*, *dal mugra*, B.

Isonandra polyantha, *kurta* B.; *kheraval*, K.

Juglans regia, *akhrot* B.; *heijuga*, M.

Kayea floribunda, *korol*, B.; *sentebel*, K.

Lagerostremia flos-regina, *jarul*, B.; *javail*, M.; *thingdon*, K.; *buanglang*, Kab.

Machilus villosa, *sundi*, B.; *uningthou*, M. *Michelia champaca*, *champa sundi*, B.; *leihao*, M. *M. montana*, *champa*, *sundi*, B.; *leihao leisang*, M.; *manou*, K.

Mangifera indica, *am*, B.; *heinou*, M.; *inba*, Kab. *theihai*, K.; *Melia azedarach*, *drek* or *goraneem*, B.; *seijak*, M.

Nephelium longana, *lechu* B.; *nongan hei*, M.

Phoebe hainesiana, *bonsum*, B.; *uningthou*, M.

Schima wallichii, *mokria sal* or *bonak*, B.; *usoi*, M.; *iseing*, Kab.; *inkheing*, K.

Taraktogenos kurzii, *chaulmoogra*, B.; *heipouk*, M.; *matathing*, K.; *ruaih*, Kab. *Terminalia belerica*, *bhaira*, B.; *sandanglai phak*, K. and M.

Terminalia citrina, *hartaki*, B.; *manahei*, M.; *rero*, K.; *bamla*, Kab.

T. myriocarpa, *jhalna*, B.; *mazok-ngazokpau*, M.; *cherpi*, K.; *kanap*, Kab.

Tetrameles nudiflora, *tula*, B.; *tal*, M.

(*To be continued.*)

HANDBOOK OF FOREST PRODUCTS OF BURMA (REVISED EDITION), 1935

BY F. ALLSOP

A book of up-to-date information on any subject is a book worth having, and this revised edition of Sir Alexander Rodger's original handbook on Burma's forest products is no exception to the rule.

A short description of over 250 Burmese timber trees fills the

first part of the book and this is followed by another 40 pages on minor products. There is then a short chapter describing the formation and work of the Forest Department in Burma, and another on the transport of forest produce, including such useful information as the capacity of railway trucks and the charges for rail, river and sea transport. Another chapter deals with woods recommended for special uses and finally there is a very useful description of the best way to store and season Burmese woods. In the appendices there is a list of the strength figures of Indian and Burmese timbers and other information on specifications and estimated supplies.

All this information is packed into a booklet of not more than 165 pages and the author must be congratulated on producing such a mine of information within such a limited space.

As a reference book on Burma's forest products it will prove invaluable not only to those within the Province, but also to many others in India and elsewhere. It cannot be described as an entirely original work nor does it aim to be, and we recognise the handiwork of several other authors throughout its pages. In Chapter XVIII, for example, numerous extracts have been taken from Trotter's "*Common Commercial Timbers of India and their Uses*," and these have been incorporated in the text and adapted to the requirements of Burma. All such references have, however, been gratefully acknowledged by the author in the preface and we can but repeat the old adage that if a fact is worth mentioning at all it is worth mentioning several times, and it is only by repeated utterances that a conservative world can be brought to see the light.

The booklet is well printed and appears to be remarkably free of errors, and we hope other provinces will follow the good example of Burma in producing such an excellent little handbook on the provincial forest resources.

A TEXT-BOOK OF FOREST MANAGEMENT

BY M. R. K. JERRAM, M. C., ASSISTANT LECTURER IN FORESTRY, UNIVERSITY COLLEGE OF BANGOR. PUBLISHED BY CHAPMAN AND HALL LIMITED

In the preface the author seems to imply that this book might take the place of Schlich's Volume III, now out of print. This is asking for a very high standard of criticism. I do not consider the book approaches the level of Schlich's Volume III, though naturally it is more up to date. Judged, however, entirely on its own merits it is a good book.

It is divided into three parts. Part I—the foundations of forest management (in five chapters)—discusses the various fundamental principles of a normal forest, increment, rotation, distribution of age classes, etc., leading on to the relations between the growing stock, increment and yield. It then proceeds to discuss the silvicultural systems in relation to yield regulation and finally various methods of yield regulation both for regular and irregular forests.

Part II deals with the "Preparation and control of a working plan." This contains four chapters starting on preliminary matters like survey, rights, etc., followed by the more detailed field work, the working plan report and finally the control.

Part III deals with forest finance in six chapters. It starts with a few general economic principles, then summarizes the problems. After giving the formulæ it goes on in Chapter IV to the solution of the problems. There follows a chapter on the choice between agriculture and forestry and finally one of general conclusions.

To me personally who have been dealing more especially with these problems for a large part of my service, this book was extremely interesting and helpful. But I am not quite sure that that was not because I knew it beforehand. I am not so sure the student would follow all of it, but perhaps that is hardly to be expected with so complicated a subject.

A great deal of the book looks at problems from rather a new angle, for example, I cannot recall any text-book in English which

points out that forestry may be a *safer* investment than consols and, therefore, a lower interest rate should normally satisfy the owner and that its real value can only be judged in relation to other commodities rather than directly in terms of money. But it is only stated and not really developed as an argument, yet Mr. Jerram must know that a large number even of professional foresters are none too clear about that point.

Excellent though this little book is in various ways, it contains some curiously loose statements. For instance, under a heading dealing in general with "Felling series under regular shelterwood systems of natural regeneration," it says "the yield is regulated by periods and adjusted as closely as possible for each year by volume only." In actual fact it is usually regulated by allotting reduced areas to periods, sometimes reduced to one, and within the period by yearly volume within Periodic Block I and by yearly area outside —but it is not always or necessarily so.

Equally under "Irregular forests" in italics it says "*the yield can only be regulated, if at all, by prescribing the number of trees or volume to be felled.*" But that is not correct. Any number of yields for irregular forests in India have and are regulated by area only. A poor form of yield regulation perhaps, but a perfectly possible and common one.

Nor would most of us quite agree with his definition of a compartment on page 19, in fact it disagrees itself with the printed definitions on page 143.

Surely also he is inaccurate on page 40. He mentions Duchaufour and it reads as if all the rest of the page was his calculation. I speak from memory but surely Duchaufour's only point was the calculation of the reduced area by crown cover determined by the diameter squared multiplied by a constant.

It is perhaps unfair to cavil at these details when so much is so good, but it seems a pity they should exist when the rest *is* so good.

This is definitely a book to buy and read.

S. H.

A SHELLAC PATENT INDEX

BY R. W. ALDIS, PH.D., D. I. C.

This volume of patent abstracts has been collected from the various resources of the library of the Indian Lac Research Institute, Ranchi, and the author is to be congratulated on the energy and resource which has resulted in such a large store of information being collected in a place so far away from the patent libraries of the world.

The author remarks, and we agree with him, that many of the early patents are now of little more than historic importance. This is not surprising as the progress which has been made during the last decade or so has brought to light many factors which were not known to the early workers on shellac.

The author makes a remarkable statement that the " users can rest assured that the rocketting prices which shellac has displayed in the past will never be seen again." This is too good a thing to be true, but if it is then there is a bright future for the lac cultivator, for steady prices will be entirely in his favour.

L. R. S.

EXTRACTS

TIMBER FOR AIRCRAFT

The increasing use of timber for the construction of commercial aircraft, and the new demands by industry for wood pulp chemically treated, were stressed by several speakers at the opening ceremony of the first " Timber in Aircraft " Exhibition ever to be arranged in conjunction with a museum in this country, at the Liverpool Museums, William Brown Street, on Wednesday.

The exhibition was declared open by Sir Roy L. Robinson, Chairman of the Forestry Commission, who said it was appropriate that Liverpool should stage an exhibit of timbers, for she was one of the largest importing centres in Great Britain. Examining statistics, he found that from 10 to 12 per cent. of the total value of wood or timber imported into Great Britain found its way into Liverpool. Sir Roy added that wood was in many respects an ideal material for the construction of the members of aircraft wings and similar structural purposes. It was strong, elastic, light, relatively cheap, and easily worked. It followed, therefore, that for commercial purposes, where cheapness was of more importance perhaps than for military purposes, wood still continued to hold its own. There was a time when the metal propeller might completely oust the wood propeller, but there again, he understood, there was a reversion towards wood.

"The casual observer has been so struck with the changes which have occurred that he had been apt to say that the day of wood is over," said Sir Roy, "but that this is not so becomes apparent at once when I tell you that we use just as much wood to-day as we did before the war. In fact, the consumption of wood in any given year in not a bad index of the state of prosperity in a country. The real fact of the case is that wood is a very raw material, with a unique combination of properties, and that as one use diappears others spring up to take its place. There is a growing tendency to treat wood more scientifically."

Referring to home-grown timber, the speaker said we were not very well blessed with woodlands in this country, although certain Municipalities, apart from Government activities, had interested themselves in growing timber. He paid tribute to Liverpool's part in the afforestation scheme at Lake Vyrnwy, and said it was a fact that if we take more trouble in the growing and marketing and in using our home-grown timbers the woodlands of the country would be a great deal more profitable to their present owners, and contribute considerably to the relief of unemployment in rural parts.

* * * * * * * *

(*Timber Trades Journal*, 25th April 1936.)

AUSTRALIAN TREE—OLDEST LIVING THING ON EARTH

Queensland claims to have the oldest living thing on earth. It is a macrozamia, a tree about 20 ft. in height and estimated to be more than 12,000 years old.

In the Tamborine Mountain reserve there is a whole grove of macrozamia, the youngest of them being 3 ft. in height and 3,000 years old. When Professor Chamberlain, of Chicago University, was appointed to collect data concerning macrozamias in various parts of the world, he travelled all over the globe, and the largest specimen he had seen prior to coming to Queensland was between 6 and 7 ft. in height and was found in South Africa.

He was amazed, therefore, when he found in the Tamborine Mountain reserve a whole grove of macrozamia which measured over 20 ft. in height, and whose ages he estimated to be between 12,000 and 15,000 years.

The largest macrozamia which Professor Chamberlain had ever seen and weighing 85 lb., as against the South African record of 35 lb., contained 151 seeds, and these were sent to America. One seed was planted in each of America's 151 national parks. Now each of the seeds has germinated, so that a descendant of Queensland's macrozamia is now growing in each of the national parks of America.—

(*Times of India*, 7th May 1936.)

WOOD CROSSING SLEEPERS

Immune from Competition

Railway-crossing sleepers stand out as a firm fortress of wood utilisation against all the assaults of changing times, new materials and new methods. According to Professor Nelson C. Brown, Head of the Department of Forest Utilization at the

New York State College of Forestry at Syracuse University, the question of a practical substitute for the wood crossing sleeper has been long considered, but it is definitely settled in the negative " for as long a time ahead as we can see."

" The wooden crossing sleeper has clearly demonstrated its superiority over other forms," Professor Brown tells the American Wood Preservers' Association. He continues: " In spite of over 2,500 patents issued by the Government office in Washington during the past fifty years for various forms of substitute crossing sleepers, none has been adopted to date. Experience in Europe shows that the trend is now definitely back toward the use of the wooden crossing sleeper, in spite of exhaustive experiments and extensive use of metal and other forms. The matter resolves itself into relative prices of creosoted ties and substitute forms.

" On an annual renewal cost basis, there appears to be no hope for the substitute crossing sleeper. For example, a creosoted sleeper can be placed in the track for a round figure of \$2 including the initial cost, its transportation, treatment and placement. If such a sleeper lasts 20 years the annual renewal cost with interest at 6 per cent. is about 16 cents. If a substitute sleeper could be produced for as little as \$3 (although \$4 would be a more near estimate for large-scale production), the substitute would have to be in service well over 100 years before the annual renewal cost would be as low as that of a creosoted wooden tie. Corrosion and other deteriorating influences, particularly in industrial districts, have demonstrated the failure of the metal cross-tie in Europe. Furthermore, the automatic block signal system, widely adopted in America, requires the insulation of one rail from the other and is a further serious handicap for substitute sleepers."—(*Timber Trades Journal*, 18th April 1936.)

TIMBER

CHAPTER IV.

The value of imports to the United Kingdom of timber classed as unmanufactured during 1935 was £35,564,000 as against a value of £39,497,000 in 1934. The decrease was under softwoods and apparently due to excess imports during 1934. Imports of hardwoods (hewn and sawn) rose to 775,000 tons (of 50 cubic feet) in 1935 as against 740,000 tons in 1934, and an average of 730,000 tons for the 5 years ending 1930, taken as the last period of normal trade.

Details are not yet available of the quantities of timber imported from India other than sawn teak. Sawn teak imported from India during 1935 amounted to 35,760 tons valued at £638,400 as against 27,400 tons valued at £495,300 in 1934.

Sales of timber other than teak through the medium of this office were 973 tons in 1935 as against 1,279 tons in 1934. The decreased sales are mainly due to the fact that the Indian market is more remunerative. During the quarter under report the sales were 613 tons and deliveries against previous sales were 408 tons.

Imports of plywood to the United Kingdom during 1935 were 12,475,491 c. ft. valued at £3,497,960 as against 10,124,801 c. ft. valued at £2,738,919 in 1934 and

8,101,097 c. ft. valued at £1,848,337 in 1933. Practically all this plywood comes from outside the British Empire.—(*Extract from Quarterly Report of the Indian Trade Commissioner, London*, October—December 1935).

DECAY FOLLOWING FIRE IN YOUNG MISSISSIPPI DELTA HARDWOODS

BY GEORGE H. HEPTING.

(*Assistant Pathologist, Bureau of Plant Industry, U. S. Department of Agriculture, Washington, D. C.* (*Technical Bulletin No* 494, *December* 1935).

SUMMARY

During the summer and fall of 1932, 602 fire-scarred trees of 9 species of Delta hardwoods were dissected and analyzed for decay and insect activity. The trees were between 3 and 11 inches in diameter, and were taken from 4 parishes in Louisiana and 3 counties in Mississippi.

Forest fires have been of frequent occurrence in the Mississippi Delta area at least for the past 30 years, with the fire seasons 1917-18 and 1924-25 outstanding in severity of damage done during those seasons.

Fire scars healed most rapidly in the oaks and red gum, followed by ash, hack-berry, and persimmon.

The greater the number of years since scarring, the greater the proportion of scarred trees decayed. Of the species studied, hackberry was found to be the most susceptible to initial infection, followed by the oaks, ash, red gum, and persimmon.

Following scarring, in red gum and persimmon, wound gum is produced just under the scarred surface, which protects the trees against infection. Much of this protective effect is lost, if subsequent fires kill the exposed sapwood.

Decay spread upward from the fire scar most rapidly in the oaks (2·3 inches per year), followed in order by ash, red gum, hackberry, and persimmon.

A definite relation was found between the rate of decay and each of the following factors: Age of tree, percentage of tree circumference scarred, diameter at the time of scarring, present diameter, and fungus causing the decay.

The breaking-over of young trees at the base, because of decay following fire-scarring, was found to be of infrequent occurrence and chiefly confined to overtopped trees and trees otherwise in poor vigour.

A large number of fungi, from several families of the Hymenomycetes, were found to cause decay behind fire scars in the Delta area. Many of these fungi, including *Lentinus tigrinus* and *Polyporus lucidus*, can rot dead sapwood, old sapwood of living trees, and the heartwood of living trees. But one fungus in any one tree was responsible for the major decay.

A large variety of insects, chief among which are ants and termites, invade the decayed wood behind fire scars in this area. Only one insect, *Parandra brunnea*, was found to invade the sound wood beyond the decay column for any distance. Insects appeared to play a minor role in the ultimate damage.

THE ADDRESS OF BIG CHIEF GULLY

It is the sad duty of the Committe of Gullies to report that since the last annual meeting of the Gullies. Chief Big Gully has passed on. This loss is a severe blow to our organisation at this time when we have a new enemy, the Soil Erosion Service to combat.

The Committee urges each individual gully to make every effort to establish a progress record for the year. By united efforts we may be able to discourage this new enemy. A new " Chief " will be elected at the next annual meeting.

By order of the Committee of Gullies—

Fellow Gullies! It is with a heavy heart that I bring you this message. I have deeply appreciated the honour that you have bestowed upon me for the past decade. Some of our young members who are quite good sized to-day have been born during my time of office. I realize that I am aged; that my efforts have become more feeble with each of the passing years. My sides are heavily grown with brush and grass, my lower limbs are desecrated with trees and even my head and upper limbs are now becoming clogged with small brush and grass. I know my life is nearly run. I do not wish sympathy or pity. My life has been full. I have ruined 4 acres of land; I have killed 2 horses and 4 cows. Is there one among you who has done as much? But I have made my mistakes and it is of these I wish to speak. I will speak briefly of our allies and at length of our enemies. I hope especially that our younger members will heed some of the warnings that I will give.

It is proper that first I should classify our enemies and allies. Our first ally is run-off. Any method of cultivating land which will increase run-off is therefore an ally. Our enemies are all types of vegetation, contour cultivation, terraces, strip cropping, or anything that will reduce run-off or cover the soil so that it washes less readily. Now we have the activities of man as both an ally and an enemy. We must, however, class man as an ally. The history of our race shows that we follow man and his activities. We have never gained a strong grip on any country without man. Thus we must classify him as our ally.

A special type of man has been visiting us recently. He is from the S. E. S. The Soil Erosion Service, fellow members, is an organisation of trained men that would introduce to his brother and our ally means of cultivation and cropping practices that would wipe us from the face of the earth. Our only hope is that men who have been our allies for generations will not desert us now. If they do, I see the doom of our race. Do not become too alarmed at this new menace. They are doings of man that we will never understand. Although man, our ally, and man, our enemy, are brothers they often act as enemies. Man our ally is distrustful of man our enemy. Therein lies the hope of our prosperity.

So much for man. Now let me warn you against the neglect of cancerous growths of grass, shrubs, trees, yes, and even weeds. They may seem unimportant at the time but if let alone they will grow on you until they begin to catch soil that you are trying to throw away. As they catch soil they catch seeds and before long your system will become clogged. I know that often our ally, a big heavy rain, will come to your assistance and put you back in good condition again. But do not

depend upon it. I did, and 3 times it repaired the damage due to my negligence, but the heavy rain did not come the fourth time until it was too late. That was 5 years ago, but my death started then, and was due to my carelessness. I should have caved off these clumps of grass and small brushes. I didn't though. I laughed at them ; I wanted them to get a little larger before I destroyed them. I even forgot them for a period and when I again remembered it was too late. But even in my death struggles it is with pride I view my tortuous length and great depth. I will die knowing that what I have destroyed will never be tillable again.

Enough of warnings. In closing let me say I am proud of our record in this community. The tabulated record of the year's programme is not at hand, but within my memory we have ruined 1,000 acres of good land, killed 37 head of livestock, and generally depreciated the value of all the farms on which we live. It is a record of which to be proud. Thank you.—(*The Land, To-day and To-morrow*, October 1934.)

AUSTRALIA ACTS TO HALT SPREAD OF SOIL DRIFT

Following the announcement by the Australian Council for Scientific and Industrial Research that investigations had been started into the cause of soil, pastoralists have waited on the Government with a request for immediate assistance to save large areas of country from being denuded of natural timber and thus prevent their becoming desert. Speaking on behalf of the Cabinet, the Commissioner of Crown Lands, Malcolm McIntosh, said it was imperative that something should be done, if legislation were found to be necessary the Government would not hesitate to introduce it.

The Speakers of the delegation were large holders of land and they told of thousands of square miles of country in the far northern districts which have been damaged by the wholesale removal of timber. They said they were agreeable to legislation to stop without delay the cutting of edible trees and bush. .

EXTENDING SOUTHWARD.

It was pointed out to the Minister that the holder of a perpetual lease had the right to cut and destroy any timber, and many thousands of trees were being felled for posts. The soil drift is now extending southward into the agricultural country.

When one large landholder urged restrictions on timber cutting on perpetual leases, Mr. McIntosh reminded the deputation that such a request would mean the breaking of covenants. This was met by the statement that the whole position was now so serious in South Australia that the consideration of rights of individuals was of little account, it was a national concern.

DANGER OF EROSION.

A member of the deputation told the Minister that he was holder of extensive perpetual leases, but, in view of the situation that had arisen, he was in accord with the suggestion that the cutting of natural timber should be protected. He said that in one district in the north there were 3,000 squares miles of country on which the original scrub still existed, and if it were destroyed, erosion and drift would follow.

Another pastoralist said that drift had extended as far as 200 miles into country in which he was interested, and, apart from prohibiting the cutting of native timber, the endeavour should be made to plant trees that would grow in arid country.—(*Christian Science Monitor*, 4th November 1935).

BIRD PRESERVATION IN BURMA

Our Topic on Bird Preservation has brought the following remarks from Burma from "A. W. K." in the hope that Christian Missionaries, and the Government Department of Education, may take notice, and include in their curricula a course of instruction on the pressing necessity of Bird Preservation.

The conditions in Burma are pretty bad, says A. W. K., adding, "the very people who should know better are the chief destroyers of bird life. Leaving aside the wild hill tribes who kill to eat and cannot be interfered with, we find that the Burmese become persistant and relentless in their destruction of bird life *as soon as they lose their respect for their Buddhist religion.*

"If you enter a Government School you will find coloured pictures of animals and birds on the walls sometimes. The creatures shown may be found from frozen Alaska to Honululu—but they are most certainly never seen in Burma! Here the children may well learn to distrust 'education,' for they will see that the 'sat' (sambhar) is wrongly shown with too many points (the picture really being one of a European red deer ").—(*Times of India*).

TIMBER RESEARCH IN AUSTRALIA UNDER DIFFICULTIES

Admiration of the good work accomplished by the Division of Forest Products of the Australian Council for Scientific and Industrial Research is all the greater when something is known of the difficulties under which the activities have been conducted since the Division was formed six years ago. In the beginning the staff was, of course, quite small, and it was housed at the head office of the Council in Melbourne, pending the erection of suitable offices and laboratories. Almost immediately, however, there came the blast of depression which knocked on the head the plans for building and equipment which had been made, and the officers of the division have since been struggling along manfully in the stables, coachhouses and lofts at the rear of the Council's head office. The marvel is that so much useful labour for the timber industry has been done under conditions of such difficulty. Now the Federal Ministry has decided to provide £25,000 for permanent laboratories for the Division of Forest Products, to occupy an excellent, centrally situated position near Melbourne. The news is good for two reasons. Fristly, it shows that Australia is now experiencing better times. Secondly, it gives unmistakable evidence that timber research is acknowledged to be a matter of first-rate importance.—(*Timber Trades Journal.*)

The following information is extracted from the Seaborne Trade and Navigation of British India for May 1936—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	MONTH OF MAY			MONTH OF MAY		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER				R	R	R
Deal and pine wood, cubic tons	1,683	751	1,379	1,18,391	45,910	80,576
Jarrah wood .. ,,	..	..	..	..	..	..
Teak wood—						
From Siam .. cubic tons	247	1	510	26,624	55	62,717
,, French Indo-China ,,	..	..	296	..	1,747	29,189
,, Other Countries ,,	..	..	..	..	..	..
Total .. ,,	247	1	806	26,624	1,802	91,906
Firewood .. .. tons	122	26	36	5,969	394	540
Sandal-wood .. .. ,,	23	67	45	10,259	20,041	12,667
Sleepers of wood for railways .. .. ,,	..	..	..	..	..	..
Logs and timber for matchmaking .. ,,	..	..	997	..	..	55,313
Other kinds of wood and timber .. ..value	..	..	..	1,67,879	1,67,012	46,394
Plywood and other laminated wood, *other than* veneers for matchboxes .. tons	..	..	221	..	..	55,747
Manufactures of wood, *other than* furniture and cabinetware .. value	..	..	..	1,37,708	2,44,211	1,15,782
Total of Wood and Timber ,,	..	..	..	4,66,830	4,79,370	4,58,925

EXPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of May			Month of May		
	1934	1935	1936	1934	1935	1936
Wood and Timber						
Teak wood—				R	R	R
To United Kingdom, cubic tons	4,092	1,076	4,305	9,49,368	2,03,039	9,41,789
,, Germany .. ,, ,,	282	208	274	71,998	50,592	63,557
,, Belgium .. ,, ,,	43	54	45	8,536	10,142	6,625
,, Iraq .. ,, ,,	64	50	45	13,278	12,713	6,486
,, Ceylon .. ,, ,,	41	146	174	5,100	20,232	19,083
,, Union of South Africa .. ,, ,,	643	429	483	1,48,520	71,344	96,513
,, Portuguese East Africa .. ,, ,,	10	29	138	2,300	4,780	24,827
,, United States of America .. ,, ,,	..	40	..	..	8,872	
,, Other Countries ,, ,,	621	513	245	68,631	75,134	56,301
Total .. ,, ,,	5,796	2,545	5,709	12,67,731	4,56,848	12,15,181
Share of Bengal ..cubic tons	..	..	..	..	..	..
,, Bombay .. ,, ,,	487	54	57	51,553	13,129	10,877
,, Sind .. ,, ,,	..	..	36	61	..	4,500
,, Madras .. ,, ,,	..	6	..	..	250	..
,, Burma .. ,, ,,	5,309	2,485	5,616	12,16,117	4,43,469	11,99,804
Total .. ,, ,,	5,796	2,545	5,709	12,67,731	4,56,848	12,15,181
Teak Keys .. tons	342	..	349	46,709	..	50,664
Firewood .. ,,	..	13	..	..	175	..
Hardwood (*other than* teak)—						
To United Kingdom, cubic tons	95	23	135	9,795	2,300	15,524
,, Other Countries ,, ,,	1	..	5	155	..	253
Total .. ,, ,,	96	23	140	9,950	2,300	15,777
Sandal-wood—						
To United Kingdom .. tons	15	10	1	19,500	12,060	1,000
,, China (*excluding* Hong-Kong) .. ,,	..	8	14	..	11,700	17,770
,, Japan .. .. ,,	..	5	..	..	5,600	..
,, Anglo-Egyptian Sudan ,,	4	3	7	3,940	2,245	7,940
,, United States of America .. .. ,,	..	7	60	..	7,040	62,000
,, Other Countries .. ,,	2	9	24	3,600	11,512	29,673
Total .. ,,	21	42	106	27,040	50,157	1,18,383
Other kinds of wood and timber .. .. value	..	..	..	20,266	65,060	72,318
Manufactures of wood, *other than* furniture and cabinetware .. .. ,,	..	..	..	12,370	4,683	10,576
Total of Wood and Timber and Manufactures thereof ,,	..	..	..	13,84,066	5,79,223	14,82,899

NOTE ON LANTANA CAMARA IN THE SIMLA HILLS

By N. G. Pring, I.F.S.

Lantana camara (*panchphuli* or locally *phul lakri*, is a large rambling evergreen shrub which generally grows 4-8 feet high in Simla District; associated with *thor* (*Euphorbia royleana*) it sometimes climbs to 12 feet or more. It grows on a great variety of soils, but appears to dislike a very sandy soil.

An incidence survey was undertaken in Baghal State during January 1936 by orders of the Conservator of Forests, Eastern Circle, and at the same time a general idea of the spread in the neighbouring States was gleaned.

Baghal State is situated in the outer Himalaya to the west of Simla. the area is 125 square miles and the elevation varies between 2,000 ft. and 6,700 ft. A small area is drained direct by the Sutlej, but most of the territory is drained by its tributary the Gambar river. The State enjoys a moderate climate and the average annual rainfall at Arki (3,950 ft.) is said to be 31·6″ per annum. There are 16,000 acres of demarcated forest mainly of the scrub type at altitudes between 2,500 and 4,000 ft., and 20,000 acres of dehat forest, portions of which, below 4,500 ft., have been reduced to *Carissa* (*gorinda*) and *Euphorbia* (*thor*) by excessive browsing, while most of the dehat forest above 4,500 ft. consists of overgrazed grassland.

Lantana was introduced by missionaries at Sabathu during the 19th century and was found so useful as a hedge that villagers of Bharauli ilaqa and neighbouring States planted it extensively for that purpose; Lantana reached Baghal not later than the nineties,

For the accurate survey of spread, camps were made on the outskirts of the Lantana zone and patrols were made in various directions, and a sketch map was prepared. The main zone occupies a gross area of some 20 square miles in the south and south-western portion of the State. The south-eastern, southern and western boundaries of this zone form the boundaries between Baghal and Lantana-infested areas in the neighbouring States of Kunihar, Patiala, Mailog and Nalagarh. It is interesting to note that the boundary of the Lantana zone in Baghal correlates precisely with that in Kunihar. Within Baghal State points along the northern and eastern boundaries of the Lantana spread are as follows :

The Nalagarh boundary above the Gambar river near Kumala and eastward to Santpur, Bharauli, through the northern portion of No. 5 forest to Badog, and through No. 3 forest to Bangli-Soheli. From the Badmal plateau the extreme line of spread runs S.-S.-E. along the outskirts of Damaihar through Badaihno and Paplota to Forest No. 2, where it is found dense over about 10 acres in the extreme northern corner along the Kuni khad which here forms the Baghal Kunihar boundary. The villages mentioned above are the extreme points at which Lantana was seen within the State and are marked on 4″ survey sheets. Negative reports concerning Lantana were received for the remainder of the State, but its presence was discovered one evening when spotting for birds, and it was found to be growing in several ravines and in some State fields near the Durbar. This small zone, covering a gross area of less than 100 acres, is separated by several miles from the main zone and a special patrol was undertaken along the Arki khad for a distance of several miles, as far as the Patiala border, but no trace of Lantana was found. Patrols in all directions from Arki, including the neighbouring reserve forest were also made with negative results. Camp was also made on the eastern boundary of the State bordering Patiala territory where Lantana was known to be growing, but none was found in Baghal. The main zone in Baghal State is connected with a much larger zone which extends through large areas of Nalagarh, Mailog, Patiala, Kunihar, Baghat and Bharauli; it is also found in Sirmoor State at the south-eastern

TYPICAL LANTANA HEDGE, BAGHAL STATE

LANTANA SURVIVES AND SPREADS, FOLLOWING A HOT WEATHER FIRE, BAGHAL STATE

PURE LANTANA ON A S. W. ASPECT NEAR A WATERING SITE, BAGHAL STATE

WHEN PASTURAGE IS SCARCE LANTANA IS BROWSED. BHARAULI ILAQA

end of the Simla Hills and extends north-westwards to Bilaspur State at the north-western extremity of the Simla Hills. Along this front it does not form a continuous belt, and spread in Simla District has been due to hedge planting by villagers with a gradual natural extension by seed and suckers, and what appears to be a more rapid extension through the agency of browsing and burning. It grows on all aspects, but tends to take completer possession on southerly slopes, it does not grow above 4,500 ft. and in Baghal is rare above 4,000 ft. It is not found to any extent in the valley between the lower Himalaya and the Siwaliks, neither in the Ambala-Simla-Siwaliks nor yet in the bordering plains of Ambala District, although it was observed in gardens as far west as Nalagarh near the Sutlej and Jagadhri near the Jumna. The upper limiting factor is probably cold and the lower limiting factor insufficient rainfall.

The agency of spread was studied in some detail, especially with regard to birds and rivers. Many local villagers attribute spread to birds which, including numerous migratory species, are common in Lantana areas. On the other hand, they are just as common in non-Lantana areas, and if birds are the normal agency of spread it is extraordinarily difficult to explain the discontinuity of spread between various Lantana areas, and in fact, to understand why Lantana has not increased rapidly over a much larger area. Lantana seed floats, and the risk of spread *via* rivers and canals throughout the irrigated parts of the Punjab has been suggested. The idea of water spread on a serious scale can be safely ignored because seed must have been carried down the canal system of the Punjab *via* the eastern rivers for many years, without spreading. Lantana has spread along the banks and islands of the Gambar river, but this and other rivers are also used for vast herds of goats and sheep during their passage between the high hills and the plains. Lantana occurs over a small area at Arki, near the head of a main branch of the Arki nallah, but none was found during a most careful survey along the stretch of river between this area and the junction of the Kuni khad. The lack of spread from this confined area is significant. If birds were the normal agents, then it would surely have spread into the neighbouring forest reserves ;

if water was the normal agent then it must have spread down the bed and banks of the Arki nallah. On the other hand strong support is lent to the theory of spread by browsing, because Lantana has not spread from the infested area which is either the private property of the Raja or residents of Arki and is naturally closed to browsing by itinerant flocks and herds passing through Arki. It is not inferred that isolation from browsing will absolutely prevent spread, but it is believed that spread could easily be checked were it not for the browsing factor.

An altogether false impression regarding Lantana has been created in Simla District ; periodically it is registered as public enemy No. 1 and orders regarding its eradication are issued.

Efforts at eradication commenced in 1898 and included cutting and digging up the roots, poisoning by the application of sodium arsenate, burning and various combinations of the above methods. Up to date all these attempts, separately or combined, have failed to eradicate Lantana to any appreciable extent. The results of applying sodium arsenate in varying proportion over 400 square yards of fairly dense Lantana were never recorded, but it is believed that the experiment was an absolute failure.

A detailed report on Lantana in the Bharauli ilaqa was drawn up in 1934 by Mr. Hamilton, who estimated the cost of clearing heavy incidence areas of the Lantana, of which there are 800 acres in Bharauli ilaqa, at 30 to 40 rupees per acre. Mr. Hamilton points out that up to the present the only harm the Lantana has done is to destroy village grazing ground, and the villagers can and have controlled it as far as their cultivation is concerned. He questions the advisability of Government spending so much money on the production of what is likely to be inferior village grazing ground.

Burning during the hot weather is the favourite method employed and has had the opposite effect to that desired. Fires kill off all the other species except Lantana which then spreads rapidly throughout the burnt area. In 1935 Mr. Bell, the Chief Conservator of Forests, Punjab and N. W. F. P., who had great experience of Lantana in the C. P., cancelled all previous orders prescribing the burning of Lantana.

The pulling up of Lantana has been attempted at different seasons in various ilaqas of Simla District. It is comparatively easy to pull up in cultivated areas and not very difficult to pull up from fallow cultivation, provided the ground has not been left too long or hardened by over-grazing ; in fact villagers have no more difficulty in contending with Lantana than with Ziziphus and other trees or bushes that invade such areas. On the other hand, in over-grazed ground and in the more sterile portion of the scrub zone it is almost impossible to pull up small plants by the roots, even 6 inches high seedlings growing in hard ground are apt to break off at ground level. A great deal has been said about the apathy of villagers when urged to eradicate Lantana, but any one confronted with the task of rooting up dense compact thickets of Lantana, probably mixed with *Euphorbia*, *Carissa* and other prickly bushes, is apt to lose enthusiasm after sweating blood for hours with very little result.

In Baghal State, where the rainfall is probably less than in the Bharauli ilaqa the cost of eradication would probably be greater, especially on the clays and shales which are a common feature of S.-W. Baghal. It was of interest to note that near the junction of two nallahs below the Badmal plateau a belt of *sanatta* (*Dodonaea viscosa*) formed an efficient barrier. The two species do grow together, but *sanatta* is rarely browsed and this acts as a check on Lantana spread. The State Forest Officer intends to sow *sanatta* along the extreme line of spread and on ground from which Lantana has been uprooted at Arki.

Lantana is the greatest safeguard against overgrazing, denudation and erosion : indeed for the drier ranges of these low hills it is probably the finest counter erosion agent that we have. Water-flow figures could not be obtained, but one could not help being struck with the fact that the streams which flowed from the comparatively small Lantana infested catchments contained a much greater volume than those which flowed from the much larger catchments in which Lantana was absent. On the other hand, it does not interfere to any appreciable extent with cultivation, provided cultivated areas are not left fallow for a few years and heavily grazed.

In the small zone near Arki, where it had been for many years without any appreciable spread, it was decided to eradicate it just in case it should spread into the well-managed reserve, where it would undoubtedly be a nuisance. Over a portion of the coppice working circles in Kuthar, Mailog and Nalagarh States it is a nuisance : the Sirmoor State Conservator also complains of it. "It is an ill-wind . . . . " Near Sabathu, and in a dehat forest near Kuthar, Lantana is breaking down and being replaced naturally by trees, thanks to its soil enrichment and protection properties.

A great deal has been written about its harmful effect to cattle and other stock, but in Baghal State and some of the neighbouring areas the writer saw it browsed by cows, horses and goats : it was noticed that stock generally browsed the leading shoots, including flowers and seed, and on one occasion it was particularly observed that a cow left luxuriant grass on a paddy field to nibble Lantana. Villagers stated that Lantana was not much browsed except during the monsoon when sheep also browse it. The writer's horse would not touch it, but ponies and mules used during the tour sometimes browsed Lantana, and quite probably it takes a certain amount of getting accustomed to before it can be properly digested.

Fifteen years ago, Mr. Flewett drew attention to overgrazing and resultant erosion in Baghal, in spite of which grazing by foreign flocks and herds has steadily increased. Apart from the reserves there is little demand for firewood and timber and there is no export trade owing to the distance from markets. The vast majority of forest revenue is derived from the sale of grass and grazing, but the total forest revenue is a very small fraction of the State revenues, which are derived chiefly from land revenue. Cultivation depends largely on irrigation, for which a sustained water supply is of paramount importance, and therefore Lantana is a great asset. In the circumstances it would be folly to attempt to eradicate Lantana from the main zone of spread in Baghal State.

MANIPUR FORESTS, PART II

IMPORTANCE OF BARAK DRAINAGE FORESTS TO MANIPUR STATE AND THE GOVERNMENT OF INDIA

BY D. C. KAITH, B.SC. (EDIN.),
Chief Forest Officer, Bijni Raj Court of Wards Estate, Abhayapur.

(Continued from *Indian Forester* for September 1936.)

With proper conservancy and development of these forests a new era will be opened for Manipur. Forests will give large amount of revenue, and hill-tribes, instead of being a constant nuisance, will become better citizens. The Government of India should be highly interested in that the water catchment area of Barak river system remains well afforested to prevent floods in the Surma valley districts of Assam and Eastern Bengal, while a supply of timber and other forest-produce is assured at a cheap rate to meet the ever-increasing demand of the vast population of Bengal and Assam.

Jhums and Floods.—Jhuming is going on all over Barak drainage. The census report of 1931-32 gives the population of Manipur hills as 150,839, showing an increase of 21·3 per cent. in 10 years. "The reason for increase in population must be due to good public health of the decade and to peaceful conditions which followed the suppression of the Kuki rebellion." There is an increase of 28 per cent. in the Lushai Hills and 13·6 per cent. in North Cachar Hills. It may be assumed that this increase in population will continue, till nature will step in with the law of survival of the fittest.

The pressure for *jhum* lands will increase unless hill-tribes are made to take an interest in forest conservancy through departmental operations and in a few years there will be vast clearances in the water catchment area of Barak. When both the factors, namely, heavy rainfall of 140 inches and naked hill surface caused by the *jhums*, are favourable, floods in Surma valley will become an annual affair. The disastrous floods of 1929 in the Surma valley are too fresh and nobody, neither the Manipur State nor the Government of Assam or India, want the repetition of floods which are bound to occur again if shifting cultivation is not controlled and regulated.

(2) FORESTS IN AND OVERLOOKING THE MANIPUR VALLEY.

Name and Situation.—Forests are called after the names of the hills and villages near which they are situated and are scattered all over the hills overlooking Manipur valley. More important are Langal, Heingang, Kambung, Kaoubru and Khuga valley forests.

Topography.—The valley of Manipur is 2,600 feet above the sea-level with the drainage from north (Naga Hills) to south (Chin Hills). Hills bearing the forest rise from 2,600 feet to 8,200 feet.

Geology and Soil.—Soil consists of ferruginous to black clay loam with sandstone and shale underlying as rocks.

Climate.—The climate of the valley is not liable to great extremes and average rainfall is 56·05 inches annually.

Composition and Condition of the Forests.—Forests along the foothills consist of various species of oak especially *Quercus serrata* which is gregarious and on hilltops mixed evergreen forest is met with. Towards the south of the valley there is khasi pine mixed with oak. Most of the isolated hillocks and some of the foothills are covered with coppice forests of oak, *Schima calicarpa*, chestnut, of fuel and post value.

Important forest flora with names in Manipuri, M. and Bengali, B:

Aegle marmelos, Bel, B.; *hei khagok,* M.

Albizzia procera, sirish, B.; *khok,* M.

Alnus nepalensis, pareng, M.

Anthocephalus cadamba, kadam, B.; *keli,* M.

Alseodaphne owdenii, til sundi, B.; *uningthou,* M.

Bauhinia variegata, kanchan, B.; *chingthrao,* M.

Bombax malabaricum, semul, B.; *tera,* M.

Butea frondosa, palas, pangong, M.; possibly introduced.

Castanopsis hystrix, C. indica, C. tribuloides, thangji, M.; *Cedrela toona, tairel,* M.

Dalbergia oliverii, tamalan, M.; *Dillenia indica, chalta,* B.; *heigri,* M.

Eugenia jambolana, jam, B.; *jam,* M.

Ficus bengalensis, *bot* or *bar*, B.; *khongnang tarung*, M.; *Ficus religiosa*, *aswat*, B.; *khongnang*, M.

Gmelina arborea, *gamari*, B.; *wang*, M.

Litsea polyantha, *buara*, B.; *tumitla*, M.

Michelia champaca, *champa sundi*, B.; *leihao*, M.; M. *montana*, *banya champa*, or *champa sundi*, B.; *leihao leisang*, M.; *Melia azedarach gora nim*, B.; *seijak*, M.

Phoebe hainesiana, *bonsum* or *sundi*, B.; *uningthou*, M.

Pinus khasya, *khasi pine*, *uchal*, M.; *Pyrus* sp.

Quercus grifithii, *uyung*, M. (good wood).

Q. pachyphylla, *kohi*, M.

Q. serrata, *uyung* (wood not durable).

Q. spicata, *sahi*, M.

(There are numerous varieties of oaks and there is confusion about their names in Manipuri.)

Salix tetrasperma, *panijam*, B.; *uyum*, M.

Schima wallichii, *gugra* or *makria sal*, B.; *usoi*, M.

Many species of rare orchids are found in these forests.

Injuries to which Forests are liable.—Fires during the dry season (cold weather) sweep across the hills overlooking the valley and kill down all the forest undergrowth.

Agricultural Customs and Wants of the Neighbouring Population.—The population of Manipur valley, which is 289,843, mostly agricultural, is dependent on these forests which supply timber for house construction, agricultural implements, boats, firewood and grass. Prices of forest-produce are very high due to irregular management of forests.

Marketable products.—Besides products mentioned above wealth of oak barks is enormous. Some of the oak barks contain a large percentage of tannin. Manipur exports or allows to rot hundreds of hides of cattle which can be tanned in Manipur, oak barks supplying plenty of tanning material.

Forest Administration.—Forests are not looked after by any trained staff. There are toll stations in various places sometimes run

by the police, sometimes by forest Moharrirs. Rise and fall of forest revenue depends on the honesty of the man collecting the tolls.

(3) NORTH-EAST UKHRUL FORESTS

Name and Situation.—These forests are situated round about Ukhrul, a Tangkhul Nágá village, which is also the headquarters of Ukhrul sub-division of the State. Forests are scattered all over the hills and consist of pure khasi pine with patches of oak and mixed evergreen forest on hilltops.

Topography.—The country is hilly and cut up by streams most of which flow into the Chindwin river of Burma. Hills are from 4,000 feet to 10,000 feet above sea-level.

Geology.—Geology of these hills is quite different from the rest of Manipur hills. Rocks are volcanic in origin and there is plenty of quartz, sandstone, lime and black clay found all over. Soil is deep clay loam to sandy loam in places. Brine wells are plentiful and salt is manufactured even till to-day and sold in the hills.

Climate.—The climate is healthy. Winters are severe and summers are cool. Rainfall is much less than in the western hills of Manipur—it was 67·1″ in 1931.

The Composition and Condition of the Forests.—The area of the country in which forests are situated is about 550 square miles roughly, and good pine forests occupy about 100 square miles. The rest, 450 square miles, consist of scrub jungle mostly of oak. Pine regeneration is abundant. Pine does not seem to have a long life, trees over 50 years begin to die from the top and become stagheaded. There are no arrangements for forest protection.

Injuries.—Fires are severe and a lot of pine forest is burnt every year. There is no danger from the shifting cultivation done by the Tangkhul Nágás but Kukis are invading the Tangkhul country and they will spoil the forests if not kept in check.

Agricultural Customs and Wants of the People.—The hills are inhabited by Tangkhul Nágás and they have beautiful terraced cultivation and *jhum* very little. They use pine firewood and cut up planks for house construction.

Prospects.—There is at present no possibility of selling timber locally nor can it be extracted to markets as the transport charges are prohibitive.

There is oak bark of tannin value. It is the pine resin which should be exploited from these forests. Even young pines are full of resin. There is plenty of local labour for resin-tapping operations. The forests can be made more accessible by improving the existing bridle-paths which are many and which ultimately join with Imphal-Dimapur motor road. The best thing for the State is to develop these pine forests departmentally and give a chance to the population in the hills to uplift themselves.

(4) Burma Border Forests.

These forests are situated along the Burma boundary of Manipur. The boundary is formed by the Kabaw valley, divided into Tammu township of Upper Chindwin district, and Mintha township of Hasaung Hsup, a Shan State in Upper Burma. Under the hill administration of Manipur these forests fall in Ukhrul sub-division.

Topography.—Forests are on the foothills of Kabaw valley drained by Yu river, a tributary of Chindwin river.

Geology and Soil.—Soil is sandy loam and laterite is abundantly found.

Climate.—It is very hot in summer and cold in winter. Rainfall at Tammu which is just on the Manipur border was as follows—

Year	..	1932	1931	1930	1929	1928
Inches	..	63·9	41·25	55·0	58·0	75

The Composition and Condition of Forests.—There is a belt of high forest of *eng* and teak which is exclusively confined to alluvial beds and banks of small streams. The width of the belt varies from 1 to 3 miles. Farther in, to the south, evergreen forest mixed with *muli* bamboos, and towards north, mixed oak and chestnut coppice forest appears. Mixed with *eng* there is a large proportion of *thitsi* trees. There is a good deal of *gurjan*, most of which has been tapped for oil.

Teak is stunted and very badly damaged by creepers.

Important flora.—Burmese, Bm.; Manipuri, M.; Bengali, B.—

(1) *Cedrela toona*, *toon* or *poma*, B.; *tairel*, M.; *thitkado*, Bm.

(2) *Dipterocarpus tuberculatus eng.*, Bm.; *kanyin*, M.

(3) *D. turbinatus*, *kanyin ni*, Bm.; *garjan*, B.; *yangon*, M.

(4) *Melanorrhea usitata*, *thitsi*, Bm.; *kheu*, M.

(5) *Tectona grandis*, *teak*, *kayun*, Bm.; *sagun*, B.; *ching sagu*, M.

There are *Eugenia*, *Englehardtia*, *Terminalia* and *Quercus* species found scattered over the forests.

Injuries to which Forests are liable.—Severe fires and shifting cultivation is spoiling these valuable forests. Reckless felling, girdling, burning, grazing by Burmese villagers is very common.

Agricultural Customs and Wants of Neighbouring Population.—Hill tribes in Manipur and from Burma *jhum* in the forests here and there. The inhabitants of Kabaw valley, with the exception of a few Burmese, Manipuri, Nepali and Kuki immigrants, are Shans who have wet rice cultivation and they have their timber from Burma forests. Bamboos they have from Manipur.

Marketable Products.—Teak, *thitsi* wood and varnish, garjan and eng oil, eng resin, firewood, bamboos, and canes are saleable products.

Lines of Export, Extraction, and Markets.—All the forest-produce of these forests has so far been extracted into Burma.

Elephants and buffaloes are used for dragging timber. Teak was floated down the Chindwin to Rangoon by the B. B. T. Corporation.

There is no forest administration at all. The State got about 2 lacs for teak sold to the B. B. T. Corporation during 1911 to 1922, and after that neglected these forests. Literally no money has been spent on conservancy. Burmese villages are allowed to cut whatever they like in lieu of a payment of Rs. 50 per village to the State, whatever may be the size of the village.

DENDROCALAMUS STRICTUS—INTENSIVE WORKING.

BY J. A. WILSON, I.F.S., D.F.O., CHITTOR, MADRAS.

Locality.—Pitchanur Tope, Gudiyattam Taluk, North Arcot District, Madras.

A flat area of what must at one time have been good cultivated land. Being on the then main road between Madras and Mysore it was probably taken up and made into a camping ground for troops which halted here frequently during their excursions in the Mysore wars. The old camping ground was taken charge of by the Jungle Conservancy Department who spent a good deal of money improving it and planting various shade trees.

Eventually in 1900 it became reserved forest, having been handed over to the Forest Department.

Altitude	.. About 980 feet.
Rainfall	.. 34″ unreliable and often maldistributed. Benefits both from the south-west and north-east monsoon, chiefly the latter.
Underlying rock	.. Gneiss.
Soil	.. A fairly good red loam.

Bamboos are first mentioned in 1916 by Mr. P. M. Lushington who wanted to know how they got there. No record was available.

Being near to a Ranger's headquarters it is an ideal spot in which to carry on experiments at little cost and is very easy for a District Forest Officer to inspect.

In July 1917, 15 clumps of *Dendrocalamus strictus* were thinned with various degrees of intensity and fairly close observations on the production of culms during the next 4 years were kept.

The general result is given below as in the detailed working sheet :

Date.	Total culms.	Average per clump.	Removed in 1917.	Re-tained.	Average per clump.	New culms observed.
July 1917	758	50·5	590	168	11·2	..
February 1918	..	..	..	..	..	113
May 1919	..	..	..	..	..	124
March 1920	..	..	..	..	..	138
March 1921	617	..	..	..	..	74

Serial No. of clump.	No. of culms 1917.	Re-moved 1917.	Re-tained 1917.	NEW SHOOTS OBSERVED.				No. of culms 5-3-21.
				9-2-18.	6-5-19.	19-3-20.	5-3-21.	
1 ..	19	12	7	5	4	7	4	27
2 ..	146	122	24	29	28	27	12	120
3 ..	3	2	1	2	1	2	..	6
4 ..	27	21	6	5	7	4	5	27
5 ..	31	23	8	6	9	12	3	38
6 ..	68	55	13	8	5	12	1	39
7 ..	44	32	12	9	9	8	4	42
8 ..	96	82	14	18	22	16	7	77
9 ..	41	27	14	6	11	12	8	51
10 ..	5	1	4	2	3	3	3	15
11 ..	58	40	18	7	6	13	7	51
12 ..	105	92	13	7	12	14	12	58
13 ..	38	28	10	3	5	5	3	26
14 ..	41	31	10	4	2	..	4	20
15 ..	36	22	14	2	..	3	1	20
	758	590	168	113	124	138	74	617

From the detailed working sheet, it will be noticed that intensities of thinning varied from very heavy to moderate. No young culms were extracted and the operation consisted in removing dead and defective culms 354, and healthy culms 236. Beyond this, all that is available is a record of the condition of the clumps at various times. The intensity of thinning does not appear to have had a variable effect on the clumps. The mere fact of thinning caused a certain amount of falling over, but this tendency was found in all clumps.

By 1921—the last observation—clumps were generally found to be healthy.

An analysis of the sheet shows that in 6 clumps less than 25 per cent. of the original culms were retained, in 5 clumps less than

$33\frac{1}{3}$ per cent., and in 4 clumps less than 50 per cent. The summary for the three classes is given below :

Degree of thinning.	No. of clumps.	Original culms.	Culms removed.	Culms retained.	Culms produced in 4 years.	CULMS RETAINED. / Culms produced.
Heavy	6	483	403	80	261	1 : 3·3
Moderately heavy ..	5	212	150	62	146	1 : 2·3
Moderate	4	63	37	26	42	1 : 1·6

It will be noticed that heavy thinning resulted in a higher proportionate production of culms, and that this proportion decreased as the thinnings became lighter.

In seven clumps only the number of culms produced during the 4th year after thinning equalled or more than equalled the number produced in the first year. Intensity of thinning has no influence as all degrees of thinning are represented in this group.

In 7 clumps there was a marked falling off in the production of culms in the 4th year and again intensity of thinning does not seem to be the factor involved.

By the end of the fourth year 5 clumps originally containing 35 culms or under each had more than recovered from the thinning, 7 clumps containing 35 to 70 culms each and 3 clumps containing over 70 culms each lost ground as shown below :—

No. of clumps.	Original No. of culms.	Final No. of culms.	Difference.
5	85	113	+28
7	326	249	—77
3	347	255	—92

This seems to indicate that clumps of more than 35 culms if worked regularly would gradually decrease in size (measured by number of culms) until a normal clump of about that number would eventuate which would remain constant.

My attention to the possibilities of intensive working of bamboos was first drawn by plantations of bamboos seen during a visit to the East in 1932-33, where I saw such plantations being raised in the New Territories (the mainland opposite Hong Kong) and being operated as village plantations in Japan.

That our present average methods of bamboo working are not by any means the acme of perfection I think few will deny. Year by year I lease thousands of acres for bamboo working and embody in my leases many regulations which it is impossible in practice to enforce.

Every contractor estimates before bidding what his fines for breach of conditions are likely to be, and being a prudent man adds handsomely to his estimate before arriving at his final figure, and Government is a loser thereby.

At every inspection I blaspheme at the failure of subordinates to supervise work properly, knowing that I set them an impossible task.

A certain amount I achieve, but if I can achieve low cutting and preserve young culms I feel that the contractor who presents his two limes and waits to know the amount of his fine has really made an effort and is deserving of mercy.

The removals total lacs of bamboos and the revenue realised by Government is, roughly, Re. 1 per 1,000—in many cases it is considerably less.

This being my frame of mind, I was delighted to find a playground in the *tope* (plantation) in question, and a few figures on which no one had previously tried to draw conclusions served as an indication that something might be done on a small scale.

From 1921, when the last measurement in the clumps under observation was taken, until 1933, nothing was apparently done. In that year my predecessor considered clumps too congested and had 2,409 culms marked for removal in 141 clumps (the total in the *tope*). These were sold for Rs. 71, but not worked, and were resold by me in February 1934 for Rs. 56 and worked, the work being completed by the end of August, in ample time to allow of the growth of new culms during October.

In September I had a further 350 unsound and mis-shapen culms removed and sold these for Rs. 10-8-0.

This had the effect of putting clumps more or less in order and I then issued orders putting things on to a regular basis.

The degree of thinning is determined by the activity of the clump as portrayed by its production of new culms in October. I argue that if one year I limit my thinning to the number of culms produced during the preceding season I shall maintain my clump in production until it flowers. In view of the indication that clumps may be too large—mentioned above—and also to keep clumps of manageable size I have introduced a corrective and the orders at present are—

November—December—Enumerate total culms and number of new culms, and mark for extraction as follows :

Where total culms exceeds 35, one culm more than the number of new culms.

Where total culms is 25—35, an equivalent number.

Where total culms is below 25, one culm less than the number of new culms.

The cultural rules for marking are—

(1) Avoid congestion.

(2) Remove mis-shapen or defective culms.

(3) Any balance still to be removed should be evenly spread through the clump.

(4) New culms shall not be marked.

At the end of 1934 the 141 clumps were marked under these rules. 52 clumps were immature and gave no yield. 89 clumps yielded 645 culms, sold standing for Rs. 24 and removed from June to August 1935.

At the end of 1935, 50 clumps gave no yield, 91 clumps yielded 817 culms, sold standing for Rs. 24 in February 1936. The season has been a good one and this I believe accounts largely for the increase.

On going into details I found what to me is rather a remarkable result.

Out of 141 clumps, 12 are still at the whippy stage. In the remaining 129, a total of 1,503 culms, left after the thinning of 1935, produced in October 938 new culms as under.

Size of clump.	No. of observations.	No. of culms after thinning, 1935.	Production of new culms.	Proportion.
Over 35 culms ..	5	203	137	10 : 7
25-35 ..	9	253	152	10 : 6
10-24 ..	45	729	435	10 : 6
Under 10 ..	70	318	214	10 : 6·7
	129	1,503	938	10 : 6·3

This is after working for two successive years. Referring back to the figures of the original thinning experiment we find the following for purposes of comparison and come on further matters of interest.

Growing season.	No. of culms.		Proportion.
	Before season.	Produced during season.	
1917	168	113	10 : 6·5.
1918	281	124	10 : 4·3
1919	405	138	10 : 3·5
1920	543	74	10 : 1·3

The year after thinning we had *the same proportionate production of new culms in 1917 as we are getting now in 1935.* Subsequently the proportionate production fell rapidly when no thinning was carried out, but our 1935 production is *after thinning in 1935 and 1934,* and we are still producing at the higher figure.

On paper it sounds well.

In the field I have simply personal observation to guide me. I saw the clumps before the first heavy thinning of 1934 and again in January 1936, not to mention the in-between times, and so far as I can see clumps remain quite healthy. The current year's new culms are

a sturdy lot, and a definite improvement on last year's crop. I am realising my small but steady revenue and have sold actually only 817 against 938 new culms produced, so that my younger clumps are improving rapidly.

On the face of it it seems that the practice obtaining in China and Japan of raising concentrated plantations on a small scale in accessible spots has a very sound foundation.

I hope that this note may give the incentive to others who have experience in concentrated bamboo working to give us the benefit of their opinions also.

A SHORT SURVEY OF DEVELOPMENTS IN THE USE OF *YON* (*ANOGEISSUS ACUMINATA*) FOR TOOL HANDLES

BY M. N. GALLANT, I.F.S., FOREST ECONOMIST, BURMA.

The first record of the use of Burma timber for tool handles dates back to the War, when Messrs. J.C. Dutta Bros., Ltd., were supplying *mamooty* handles of *pyinkado* (*Xylia dolabriformis*) to the Munitions Board. In 1922, an enquiry was received from the Rangoon Municipality in regard to indigenous timbers suited to the manufacture of tool handles. The Municipality proposed testing indigenous timbers and asked advice in regard to 13 possibles. *Yon* was not included and the Utilization Circle suggested adding *taukkyan* (*Terminalia tomentosa*) to the list, the species having apparently established itself at Bareilly as being suited to the manufacture of tool handles. Alongside these tests by the Municipality, the Utilization Circle commenced a series of experiments on seasoned indigenous woods from the point of view of handle manufacture.

Thus *yon* found no place in the preliminary search for an indigenous wood suited to the manufacture of handles. The first indication of its possibilities came in 1925 from the Timber Testing Section, Dehra Dun, who thought that *yon* should make a very good hammer handle, possibly superior to imported ash and hickory. On

the recommendation of Dehra Dun, a timber (*species not on record*), similar in properties to *yon*, was taken up by certain of the Indian Railways and the results were so satisfactory as almost to stop the use of imported handles. The first batches of timber used for handles were kiln-seasoned.

The period 1926-30 saw numerous attempts to place *yon* as a tool handle timber. In 1926, a shipment of *yon* scantlings was made to Messrs. Martin & Co., Calcutta. *Yon* and *kanazo* handles were sent to the Great Western Railway, England, for test and the preliminary reports were favourable. In 1927, further supplies were sent to the G.W.R. *Yon*, *panga* (*Terminalia chebula*), *petlezin* (*Vitex peduncularis*) and *thitsein* (*Terminalia belerica*) handles were supplied for test; *kanazo* was dropped as supplies were not organised. Supplies of *yon* handles were also made to the Federation of British Industries, through the Indian Trade Commissioner, London. In 1928, supplies of *yon* handles made to the Burma Railways were favourably reported on. Further trials were made in 1929 by the Jail Department and the Burma Corporation. A firm of Wigan tool manufacturers became interested, but prices for *yon* were too high for business to materialise.

In 1930, a report was received from the G. W. R. on handles supplied in 1926-27. The report was unfavourable and said of the handles supplied :

> "that they break with a short fracture, owing to being brittle and lacking in fibre. In consequence of the short fibrous nature of the timbers, the handles are lacking in resiliency and consequently when a blow is struck, there is considerably more jar to the hands than with the handles we are at present using."

Princes Risborough thought the report rather sweeping, particularly in regard to *yon*. Dehra Dun was scathing and questioned the writer's knowledge of wood structure.

Subsequently enquiries and orders for *yon* handles came in steadily. In 1932, the Indian Railways called for tenders for supply of hammer handles of *yon* and similar woods. In 1933, the South

Indian Railway asked for supply of 3,000 *yon* handles and the Southern Railway made enquiries for *yon* for shunting poles and handles. The East Indian Railway communicated with the Utilization Circle in 1933 in regard to the advisability of placing an order for 90,000 handles with Messrs. Du Bern. The same year a note on a *yon* handle was received from Princes Risborough which read—" Its period of utility came to an end in 1933, after six years of service. The shop foreman reports that the handle stood up extremely well to rough usage."

In 1933, the East Indian Railway placed an order for 37,700 *yon* handles with the Timber Research Division and the South Indian Railway placed an order for 1,350 handles. The timber used for these handles was machined at 17 per cent. moisture content after air seasoning for two years.

In 1934, the East Indian Railway called for 60,000 *yon* handles. Enquiries were received from the Bikaner State Railway and from the Nizam's State Railway, Hyderabad. The Southern Railway, England, reported that when *yon* scantlings were turned to standard weight, the coupling poles obtained were not sufficiently strong for the work in the smaller dimensions. The timber, however, gave satisfaction as handles and further samples were asked for. Tests were instituted by the Timber Research Division to see whether second growth *yon* or *yon* from young trees would not answer requirements of shunting poles for the Southern Railway.

In 1935, the Southern Railway reported that *yon* handles were satisfactory and " that they wished to consider the use of Burmese timber in future in view of the greater life which is obviously obtained from such timber." An order for 3,000 handles was placed. It was reported that " *yon* handles were found to last more than 8 months as compared with the normal 3 months for ash and hickory."

An enquiry was received from the Railway Board, Delhi, on the possibility of supply of unseasoned *yon* plank to Lillooah, Calcutta, with a view to large scale kiln-seasoning of the timber for all or a group of the Indian Railways. Once seasoned, it was intended to let out contracts for the fashioning of the handles. This enquiry marks the

peak of the Timber Research Division's efforts to market *yon*. Should it materialise, it will mean that *yon* will become the foremost timber for handle manufacture and that the efforts of the Timber Research Division will be amply vindicated.

In 1934-36, owing to lack of funds and facilities, the Timber Research Division had to turn down large orders for handles from Indian Railways. We were unable to tender for supplies to the Bikaner State Railway, The Nizam's State Railway, The Bengal-Nagpur Railway, The Bombay-Baroda and Central India Railway, etc.

The Bombay-Baroda and Central India Railway reported in 1936 that *yon* samples were far superior to "wooden, bhundi or bamboo handles usually supplied to them."

This short survey illustrates the considerable effort that must be expended in order to place a new timber on the market. It is of interest that the first indications of the possibilities of *yon* were obtained through scientific strength tests at Dehra Dun. It is probable, in the light of subsequent knowledge, that the unfavourable report on *yon* received from the Great Western Railway in 1930 was clouded by prejudice in favour of old established woods. The worker in timber is notoriously conservative and mistrustful of "new woods." *Yon* is now undoubtedly established as a superior wood for handle manufacture and reports from the Southern Railway indicate that it is even better than ash and hickory. The period of "test" is now over, but the efforts of the Timber Research Division must still continue in regard to marketing. Should the supply of scantling to Lillooah materialise, the question of the marketing of *yon* will be largely solved, though efforts will still have to be made to place the wood definitely in the home market.

The prospects seem fairly good that, in the near future, private enterprise will undertake the supply and fashioning of *yon* handles. The Timber Research Division have always tried to interest private enterprise in the supply and a small factory was opened by Messrs. Du Bern. This factory, however, is so small that it cannot cope with more than a fraction of the local supply.

The supply of *yon* in the province appears to be ample for the requirements of the Indian and British Railways. A rough estimate gives a yield per annum of 8,000 trees 6′ in girth and over. The Indian Railways require about 2,500 tons in the round (sufficient for 700 tons of blanks).

The value of the Indian Railway tool handle business is, roughly, Rs. 80,000.

Note by the Forest Economist, Forest Research Institute, Dehra Dun.

The "species not on record" referred to on page 422, line 1, is presumably *Olea ferruginea*, which was accepted by the Indian Railways for tool handles and was entered in their list of species accepted for this purpose. The remark that the use of this timber almost stopped the use of imported handles is, however, altogether too optimistic. *Olea ferruginea* is being used by the Railways for tool handles but there are still very large quantities of imported ash and hickory handles being used too. A survey of the number of tool handles used by Indian Railways showed that over 1,000,000 handles of different kinds were required annually, and from other figures collected by the Forest Research Institute it was estimated that other industries and Government Departments consumed another 1,000,000 handles per annum. There is, therefore, still a very large field for the further exploitation of Indian woods for tool handles.

SHWEBO FOREST DIVISION, UPPER BURMA

By F. G. Burgess, I.F.S.

This Division was originally one of the seven territorial divisions formed when Forest administration was first introduced into Upper Burma in March 1887, and was called the Mu Forest Division. Except for unimportant changes, involving the transfer of small areas to and from other divisions, it remained unaltered until 1st April 1922, when it was divided to form the Mu and Shwebo divisions. On 10th June 1929, an area lying in the Sagaing Civil District, formerly

administered by the Lower Chindwin Division, was added. On 1st February 1932, as a measure of economy, the two divisions were amalgamated, and called the Shwebo Forest Division, and so it remains to this day.

The Division lies between latitudes 21° 56′ and 24° 28′ north, and longitudes 94° 50′ and 96° 05′ east. It is, roughly, 175 miles long, and varies in breadth from 40 miles in the north to 72 miles in the centre, narrowing to 36 miles in the south. The northern half of the Division lies in the wet zone, and the southern half in the dry zone. The Tropic of Cancer cuts the Division roughly in half, crossing the Mu Valley railway line, which runs more or less centrally through the Division from north to south, between Pintha and Kyaikthin railway stations. Shwebo Town, which is in the southern half of the Division, is 414 miles by rail from Rangoon, and 58 miles from Mandalay.

The climate varies considerably. Whilst Shwebo has an average annual rainfall of 38 inches, Wuntho, 100 miles to the north, has a rainfall of 80 inches, which increases considerably in the hills to the north and west of the town. All this rain falls during the period June—November. Temperature charts have been maintained for the last 3 years, the highest point reached being 110° F., at Shwebo during April, and the lowest, 39° F., in the jungle during December and January. The average hot weather temperature in Shwebo is 85° F., and the average cold weather temperature, on tour, is 50° F. The difference between day and night temperatures in the cold weather is often as much as 30° F.

After the annexation of Upper Burma in 1885, the work of pacification on the west of the Mu river progressed more slowly than elsewhere, and it was not until 1889 that the bands of dacoits operating in the Ye-U district were finally broken up. There remained the Wuntho Shan State to the north, whose ruler had afforded protection to a few dacoits. In 1890 this ruler offered resistance to a small column operating against the dacoits, and this led to a general rebellion which was quickly suppressed by combined operations from Shwebo and Katha, resulting finally in 1891 in the incorporation of the greater part of the Wuntho State in the Katha Civil District.

Since the annexation, years of scarcity have been frequent, but the only year of actual famine was 1891-92, when a bad season, following on the poor harvest of the previous year, brought disaster. During this year, whole villages in the Ye-U area were deserted, and in some cases the sites were not reoccupied.

The population of the Mu Valley still shows the effect of the early wars--the occupation by the Shans during the sixteenth century, the settlement of Siamese, Portuguese, French, Dutch and Goanese prisoners during the seventeenth and eighteenth centuries. The descendants of the Shan and Siamese captives are now hardly distinguishable in language or appearance from the Burmese population. The Shan language is never used by them, though a number of the older people speak Burmese with a Shan accent. The European prisoners mostly intermarried with the Burmese population, and although their descendants have now lost all trace of their ancestors' names and languages, their mixed descent is, in many cases, obvious from their features. The religion of the original captives has been largely maintained by Italian and French missionaries.

The total area of the division is 5,158 square miles, made up as follows:

Reserved forests ..	.. 1,565	square miles
Unreserved forests	.. 1,693	,, ,,
Cultivation, town and village sites, waste land, etc.	.. 1,900	,, ,,

The northern half of the Division is divided into four Ranges, but no Ranges have been formed in the southern half, as this consists chiefly of cultivated areas, and scrub jungle. The four Ranges are further divided into beats, there being 37 of these. In the southern half of the Division there are seven beats, embracing areas where theft of forest produce is prevalent.

The staff of the Division consists of the following:

One Divisional Forest Officer.

One Assistant Conservator of Forests.

Three Extra Assistant Conservators of Forests,

(It is interesting to note that two of the Extra Assistant Conservators of Forests are Members of The Most Eminent Order of the British Empire, this honour having been granted them for their services during the Tharrawaddy Rebellion, 1930-32.)

Four Rangers.
Eleven Deputy Rangers.
Forty-nine Foresters.
One Head Clerk.
Nine Time-scale Clerks.
Four Range Clerks, and
Forty-six menials.

Under the Burmese rule, the forests were worked to produce as much as possible with no consideration for the future. The Bombay-Burmah Trading Corporation had been granted a lease to work the Mu forests for teak, and after the annexation by the British, this lease was ratified by the British Government. This firm is at present working all the forests in the Mu River drainage under a lease which will expire in 1940. In addition to the extraction of teak by Messrs. The Bombay-Burmah Trading Corporation, Limited, the division is one of the main sources of the supply of sleepers to the Burma Railways. During 1935, contracts placed with contractors working in the division amounted to—

2,82,000 1st class sleepers, metre gauge.
56,400 2nd ,, ,, ,, ,,
330 tons of special size sleepers.

Fuel is also supplied to the railway at the rate of 260,000 cubic feet, stacked, per year.

Small sized teak trees, growing on or near cultivated areas, and the butts, branches, etc., left by the lessees, are sold under licences to small traders, who convert such timber into spokes and felloes for cart wheels. Other produce utilised is, bamboos, cutch, *thitsi* (wood oil from *Melanorrhoea usitata*), *Indwe-Pwenyet* (resin from *Dipterocarpus tuberculatus*, and bees' wax), lac, and bats' guano,

The following table shows the revenue and expenditure of the Division for the last two years, compared with the average of previous years :

	1933-34.	1934-35.	*Average of 5 years* 1928-29 to 1932-33.
	Rs.	Rs.	Rs.
Revenue	3,48,986	3,04,055	5,22,052
Expenditure	1,36,433	1,33,652	1,96,391
Surplus revenue over expenditure	2,12,553	1,70,403	3,25,662

The decrease in revenue during the last two years is due to the slump in the teak market, and to the grant of rebates of 30 and 15 per cent. to Messrs. The Bombay-Burmah Trading Corporation, Limited.

As is to be expected over such a large tract of country, practically all types of forests are represented. The types to be found are—

(1) Thorn forest, composed mainly of very stunted trees of such species as cutch (*Acacia catechu*) and *tanaung* (*Acacia leucophloea*).

(2) Deciduous Dipterocarp forest, the main species being *ingyin* (*Pentacme suavis*), *in* (*Dipterocarpus tuberculatus*), *thitsi* (*Melanorrhoea usitata*), *thitya* (*Shorea obtusa*), *panga* (*Terminalia chebula*), and *te* (*Diospyros burmanica*).

(3) Dry forest, characterised by an undergrowth of stunted *myinwa* (*Dendrocalamus strictus*), with *than* (*Terminalia oliveri*), cutch, and stunted *padauk* (*Pterocarpus macrocarpus*), *pyinkado* (*Xylia dolabriformis*) and *taukkyan* (*Terminalia tomentosa*) as the tree crop.

(4) Dry upper mixed deciduous forest. The chief bamboo is *myinwa*, which on steep slopes is often replaced by *thanawa* (*Thyrsostachys oliveri*). The principal tree species are *pyinkado*, *padauk*, *hnaw* (*Adina cordifolia*), with teak (*Tectona grandis*) usually near the streams or on the higher slopes of the spurs.

(5) Moist upper mixed deciduous forest. The bamboos to be found in this type are *tinwa* (*Cephalostachyum pergracile*), *wabomyetsangye* (*Dendrocalamus hamiltonii*) and *thaikwa* *Bambusa tulda*). Good teak and *pyinkado* are the chief timber trees, with lesser quantities of *taukkyan* and *hnaw*.

(6) Lower mixed deciduous forest. Bamboo is absent in this type, and the predominant trees are teak, *taukkyan*, *yon* (*Anogeissus acuminata*), *thitpyu* (*Albizzia procera*), *zinbyun* (*Dillenia pentagyna*), *thitsein* (*Terminalia belerica*), and *thabye* (*Eugenia* species).

(7) Evergreen forest, having a dense undergrowth of prickly palms, canes and ferns, with *waka* (*Pseudostachyum polymorphum*) and *waba* (*Cephalostachyum virgatum*) bamboos. Stunted *kalaw* (*Taraktogenos kurzii*) is present in small quantities, and there are some *Cedrela* species. On the highest hills, a drier type of evergreen is found with *taungthayet* (*Mangifera indica*), *sagat* (*Quercus* species) *kanyin* (*Dipterocarpus* species), and very few bamboos.

From a touring point of view, this Division is almost ideal in its variety. The southern half is one vast plain, 600 feet above mean sea level, and intersected by dry water courses, and the canals of the irrigation system constructed by the Public Works Department. In the centre of the Division there is an area of fairly dry, undulating country, with no marked features, whilst in the northern half, are found hills rising to a height of 5,470 feet. The Mu-Chindwin watershed on the western boundary only reaches a height of 2,625 feet, whilst the highest point of the hills running parallel with the Irrawaddy River on the east reaches 2,656 feet.

The majority of touring can be done by bullock-carts throughout the year, though elephants are necessary when a visit is paid to the reserves in the east, west and north of the Division. Forest rest-houses are plentiful, and are connected by Forest Department cart roads or elephant paths. No touring can be done by motor car except for occasional visits to revenue stations at Ye-U on the Mu River, and Kyaukmyaung on the Irrawaddy River.

The shooting in the Division is good and varied. Of big game, elephant, bison (*Bibos gaurus*), mythun (*Bibos frontalis*), *saing* (*Bibos banteng burmanicus*), serow (*Capricornis sumatrensis*), *thamin* (*Rucervus thamin*), hog-deer (*Hyelaphus porcinus*), sambhur (*Rusa unicolor equinus*), barking deer (*Muntiacus* species), pig (*Sus cristatus*), tiger (*Felis tigris*), leopard (*Felis pardus*), clouded leopard (*Felis nebulosa*), Himalayan bear (*Selenarctos Tibetanus*), Malayan bear (*Helarctos malayanus*), wild dog (*Cuon dukhunensis*) and jackal (*Canis indicus*) are the most common.

For small game, Shwebo must be considered one of the best divisions in Burma, especially for game birds. Jungle fowl are very plentiful anywhere near cultivation, provided there is also bamboo forest nearby. In *indaing* forest (forest characterised by the predominance of deciduous dipterocarp species), partridge or Chinese francolin is found in considerable numbers. In the northern part of the Division, the silver pheasant (*Gennaeus Horsfieldi*) is occasionally found. Duck of many kinds, including such a rare visitor as the Bronze-capped teal (*Eunetta falcata*), have been shot at Wetlet (17 miles south of Shwebo town), which has been, and still is, a famous shooting ground for all kinds of water game birds. Snipe are extremely plentiful, and woodcock are not uncommon. Button quail are found in the same areas as partridges, while the rain quail is common in the dry crops such as sessamum, in the cultivated country in the south.

In 1932-33, a scheme for the control, and destruction, if necessary, of wild elephants in the interests of cultivation was started, and has continued up to date. Usually, three game rangers are employed for the period, 15th of August to 15th of January, at Rs. 50 per month, and are paid a bonus of Rs. 10 for every elephant killed. The financial results of these operations over the last 4 years are as follows:

(No. of elephants killed, 129.)

	Rs.	a.	p.
Expenditure	3,307	0	0
Revenue from sale of ivory	4,726	12	0
Excess of revenue over expenditure ..	1,419	12	0

During the years 1933 and 1934, an epidemic of rinderpest swept through the Division. Whether this epidemic started amongst domestic cattle and spread to wild animals, or *vice versa*, will never be known, but 226 carcases of wild animals were found, and it is estimated that over 1,000 head of game were killed off during this epidemic. One village tract alone lost over 200 head of cattle.

Socially, Shwebo (the headquarters of the Division) compares very favourably with other and better known towns. There are about 40 Government officials, made up of Europeans, Burmans, Indians, Anglo-Burmans and Anglo-Indians. In addition, there are the Local Manager of Messrs. The Bombay-Burmah Trading Corporation, Limited, two or three assistants, a Church of England Minister, who is also head of the S. P. G. School, and a Roman Catholic Priest. Half of this population live in the Civil Lines, on the east of Shwebo, and the other half live in the old Cantonments, 3½ miles east of Shwebo. There is a very good club, which caters for all sorts and conditions of men (and ladies), having a large library, two hard tennis-courts, two polo grounds, a 12-hole golf-course, a billiard table, ping-pong table, a set of cricket gear, for net practise only, clay pigeon throwers, and a dart board. It is rumoured also that the energetic Club Honorary Secretary is seriously thinking of buying a shove ha'penny board. The country around Shwebo is ideal for riding, and paper chases were held regularly during 1933-34, but gradually ceased as the "fields" got smaller and smaller. Once a year, usually at the end of July, a polo "week" (which generally lasts 10 days) is held. During this period, teams from Mandalay, Maymyo, Myitkyina and Shwebo compete for the "Dragon" and "Jubilee" Cups. In addition, there are golf and tennis tournaments, clay pigeon shoots, a paper chase, dances, etc. etc. Shwebo possesses a very fine church, where services in English are held on the first Sunday in every month. Services in Burmese are held every Sunday. Kanbalu, 46 miles north of Shwebo, is the headquarters of the Revenue Assistant, 12 subordinates, and 4 clerks of the Division. A very good Divisional Football team has been raised, and this team succeeded in winning the "Kanbalu Challenge Cup" in 1932 and

1934. There was no competition in 1933, and the teams were runners-up in 1935. In addition to football, badminton and ping-pong are played, and are proving very popular, especially badminton.

In conclusion, I tender my thanks to Maung Ohn, my hard-working and efficient tour clerk, who typed this article in his spare time.

SPECIMENS FOR THE ZOO

By A. F. Minchin, I.F.S.

Madras is a splendidly generous Province, and has frequently given away picked well-behaved elephants to zoological societies.

An elephant trustworthy with a load of children is a big financial asset to a Zoo. In Dublin, in the 1934 autumn, they were in sore straits. As readers may know, the Zoo is in Phœnix Park, where there is also occasional motor racing. One day the confidential she-elephant, who was out exercising, got involved with some racing cars. She was terribly frightened, and a disaster occurred. After that she was not so completely to be relied on that children could be carried.

Madras has just given them "Saraswathy," from Nilambur. Saraswathy was learning the mouth-organ on her way home; for that Zoo goes in for music. We hope she will be a blessing to Dublin's Fair City and especially to its pretty girls!

Apropos, hunting in early 1935 in West Somerset, we met a charming young lady, Miss Ida Ashton, of the London Zoo. We made her promises of creatures for her department, the Reptile House. A conscience guilty about those assurances bids us to write to the *Forester*. Even if chances of sending things do not occur, the bits about how to pack snakes are entertaining: Miss Ashton wrote:

"We are always extremely grateful for anything sent us, as it is impossible to get from dealers anything but the very ordinary stuff and that at the most exorbitant prices—we have paid as much as £5 each for cobras!

"Absolutely anything you come across in your wanderings is likely to be of interest to us and most probably may be entirely new to our collection. I suggested snakes because they can be dealt with more easily—just slip each into a separate cotton bag and dip it in a bucket of water for a few minutes to give it a drink, and it will last months! The most successful 'parcel' we've received was one last year that arrived in this way. A large box with hinged lid had quantities of cotton bags tied on to screw-eyes in the lid, so that when the box was shut they each hung down separately. Every one arrived in splendid condition and one Russel's Viper managed to give birth to over thirty healthy youngsters on the way! The latter possibility, incidentally, is why we like bags in preference to boxes which may have cracks through which things eke out—you can tip out a bag and there you are, whereas you may open a box expecting one beast and a dozen dart out at you.

"Lizards, though perhaps more charming, are not so easy to transport unaccompanied. They need food in the way of cockroaches, and water regularly and even then often don't survive the journey.

"Frogs and toads again are a joy to us, but 'nervy' travellers. The former particularly will jump about and knock their noses causing a raw wound which very rapidly goes septic and spreads, as well as encouraging a fungoid disease *which* is contagious."

* * * * * *

"Freight is best paid this end, and the Society is always ready and willing to pay this and other expenses."

* * * * * *

NOTES ON THE COLLECTING AND TRANSPORT OF LIVE REPTILES AND BATRACHIANS FOR THE LONDON ZOO, REGENT'S PARK, LONDON, N. W. 8.

The specimens particularly wanted by the Zoological Society are those not often obtained from dealers. Large and striking species are probably better known, but make attractive exhibits for the general public; while small dull-coloured ones are more likely to be of scientific interest. Because a species is very common locally it does not follow that it is of no interest; it may have only a local range,

or may not have attracted the attention of dealers. As most specimens reaching the Gardens are brought by sailors, those coming from inland places or far from large ports are likely to be more acceptable.

Collecting Snakes.—A cotton bag, say, 2 feet by 8 inches, closed by *two* safety pins, and a forked stick, which can be cut on the spot, are the only appliances needed. The snake is pinned to the ground by the fork across the neck, and picked up by the neck to transfer it to the bag. There is no danger if care is exercised, and the only risk arises when familiarity has bred contempt. The second safety pin is to confine the first snake to the bottom of the bag while a second is being introduced. In an emergency a bag can be improvised by pulling a handkerchief through a finger ring. If a bottle is used instead of a bag care must be taken not to leave it in the sun, or the heat rapidly kills the snake.

Collecting Lizards.—Most lizards can be noosed with a cotton running loop on the end of a long stick. The more nervous ones may need a cane 10 feet long to approach them, and large species such as iguanas and monitors need stout string for the noose. Digging lizards out of holes is often an impossibly long task, for their burrows may run many yards through stoney ground; often they can be headed off from their holes and made to take refuge in smaller crannies or under logs from which they can be picked out. " Gassing " lizards from their holes with calcium carbide occasionally works. If native boys are promised a few cents they will usually bring more of the commoner lizards than one could catch oneself in twice the time, especially if they are shown how to noose them.

Collecting Batrachians.—No special advice can be offered as to catching frogs, newts, etc., beyond searching their obvious haunts and breeding spots. Many are caught better by night with an electric torch. For all reptiles and amphibians it is often worth while to chop into hollow trees in forest country, and to explore rotting logs.

Care before Shipment.—There is never any hurry to feed the newly-caught specimens; few will suffer for a month's starvation if necessary, but water should always be provided, even though they

are never seen to drink. Some lizards will only take water in the form of drops sprinkled on leaves, and some desert species only absorb moisture through the skin and should be sprinkled daily. Frogs do not drink, but must be kept moist by bedding on wet moss, etc. As a general rule snakes that hunt by day feed on lizards or frogs, and night hunters eat mice, and food may be offered accordingly, but live mice or rats should never be left in a cage, for they often kill or damage the snakes. Lizards as a rule eat insects of many kinds, and can be trusted to avoid poisonous ones. A fly trap or a stock of mealworms should be kept going for them if they are to be kept long before shipment. Many of the larger lizards will take scraps of raw beef while iguanas and other vegetable feeders take lettuce leaves.

Shipment.—Small reptiles often travel successfully by post. Packages should be marked "SCIENTIFIC SPECIMENS OF NO VALUE" *not* "LIVE ANIMALS." Many countries have regulations prohibiting live animals in the post, and in any case poisonous snakes should never be so sent. Frogs if packed in damp moss travel well by post.

Large, delicate, valuable or poisonous animals can only be sent in charge of a passenger or member of the crew. If this is done and an airmail letter sent at the time of their dispatch announcing when and where they will arrive, they can be met either at the English port or London terminus.

A friendly drink with the Captain will usually result in reptiles accompanying a passenger, travelling free of charge, and if objection is raised to carrying live snakes it can often be met by the suggestion that they should be stowed in one of the ship's life-boats.

Packing for Shipments.—(1) Poisonous snakes are better sent each in a separate cage so that in the event of death of one of them the cage has not to be opened to remove it. A suitable cage is one made of stout well-seasoned wood that will not warp with moisture, and without knots that might fall out. If fitted with mosquito wire gauze this should be double, with at least an inch space between the layers, and on top of the cage, so that water may be poured through it to a drinker below.

IN GANJAM FORESTS—MR. H. A. LATHAM, I.F.S., ON NATURAL HISTORY INTENT

Photo by Alyson Minchin, 1918

(2) Non-poisonous snakes may be packed several together, but need an equally safe cage in view of the general horror of snakes. Snakes roughly equal in size can be packed in a very small space. It is a mistake to feed them on the voyage, though they need water, and cages should be permanently nailed or screwed up. To avoid accidents in unpacking please label "SNAKES."

(3) Lizards need more space than snakes; a box a foot square and six inches high would accommodate four lizards each eight inches long. Small lizards and vegetable feeders are better for being offered food three or four times in a voyage of a month's duration, or a supply of insects may be packed with them. A small hole stopped with a cork serves to introduce food and water and hook out dead ones without risk of others escaping.

(4) Frogs need a well padded box, or they rub their snouts raw leading to a bone infection which kills them. They are best kept moist on a bedding of sloppy-wet clean cotton waste or other non-fermentable material. Ventilation can be provided by wrapping wool or cotton waste round separate lid boards with a bandage, and nailing on with $\frac{1}{4}$ inch intervals. They require no food during the voyage, but the bedding must be kept constantly moist.

NOTE.—It is not really advisable to send reptiles or batrachians to arrive in England from about the beginning of October to the end of March, on account of frost during the latter part of the journey.

* * * * *

If these remarks and extracts renew someone's interest in Natural History, he will really be the gainer himself. An Indian Officer of the I. F. S. remarked that English boys learn Natural History hobbies from their parents; and that as forest men it gives them a pull over their Indian confreres who suffer for lack of distractions in the forests.

In the Madras Presidency, one of the boldest snake-catchers of our time was Mr. H. A. Latham. A perhaps untrue but anyhow appreciated tradition of him runs thus: Deep peace and a hot weather afternoon. Mr. Latham, the Conservator, returning through the forest from inspection: in his right hand a butterfly net, and in his left, clasped at the correct spot, an incensed snake he had caught.

A stout Range Officer (name unfortunately not discovered) completes the scene: meditative, yet keeping his distance from the reptile, following home his officer.

Sudden transformation: Mr. Latham is away fifty yards after a butterfly! whilst the Ranger stands frozen with horror! In his hand the neck of the lively serpent that had been flung into his keeping before his mind had begun to work!

The photograph of Mr. Latham (Plate 44,) in a Ganjam sal forest setting will be appreciated. He is bug-hunting near Edinburgh these days.

DISFORESTATION.

By "Tommy Brock."

With reference to Amimad Orishe's article on Disforestation in the May number of the *Indian Forester*, I would like to take this opportunity of supporting his views.

The necessity for continuity of forest policy is I think recognised by most foresters, and in order to obtain this we must have security of tenure. Most forest officers in this country must have, during the course of their service, received applications for disforestation which, upon inquiry, have proved to be quite unjustified in the interests of the community as a whole. Such disforestation it is true may benefit individuals, but it is often the case that land shortage is not as acute as the petitioners would have us believe and that suitable land can be found for them outside the reserve, though perhaps at a distance and of an inferior quality.

The position is not of course the same in all parts of the country, and in some places it may well be that all applications for disforestation represent a genuine need. I can only speak for my own province where this is not the case as yet.

I think that most of us who work in this country in the interests of forestry will also admit that the general public has little, if any, "forest sense," and the same can probably be said of many countries besides India.

The average layman does not, in the opinion of the writer, realise what an important part forests play in the economic welfare of the community.

It is quite true that many of our reserves are not of very great importance as timber-producing units, but I maintain that forestry is something far more than a timber-producing concern and that forests fulfil many more services to the community than that of supplying first-class timber. This view is nothing new to readers of the *Indian Forester* and needs no explanation. My point is, however, that many of the reserves which do not produce first-class timber do fulfil a very useful purpose in providing the local inhabitants with minor forest produce, firewood and in some cases grazing; in fact many of our reserves have only begun to fulfil their true purposes since the Unclassed State Forests have become exhausted owing to an increase in population and the consequent extension of cultivation.

The value of the reserves, from this point of view, is often unappreciated by the local villagers themselves, who appear to think that, once the reserve is disforested, they will get an increased area for cultivation together with an area of Unclassed State Forests which will supply them with free forest produce and grazing. It is quite true that this will be the case for a few years, but what they and their well wishers fail to realise is the fact that this new requisition will soon have gone the same way as the old Unclassed State Forests and that they will then be in the same predicament as before.

It seems to me, therefore, that as the Forest Department is probably the only body which fully realises the importance of their forests to the community, they have a very important charge in preserving them for the use of posterity, and that it is a mistaken policy for them to do anything which may weaken their position. The very fact, however, that we should suggest that, as a matter of principle, each and every refusal of an application for disforestation should be fully justified by the Forest Department, appears to me to be an admission that we often cannot justify such refusals and that the work of our predecessors was at fault. Such an admission is apt to give the general public a bad impression of our work, which

I personally do not believe to be justified, although of course some mistakes have been made; and as others are apt to take us at our own valuation, this is not a state of affairs which is calculated to improve the status of the Forest Department.

On the other hand, I quite realise, that, owing to an increase in population, conditions have changed since many of our forests were reserved; and although, as I have already pointed out, this increase in population has in many cases accentuated the importance of our reserves, there are undoubtedly cases where the reverse is also true. This being so, disforestation of certain reserves may be necessary. I agree, however, with Amimad Orishe that such an important and complex question is not one that can be settled by the individual and that it should be left to the Local Government to decide what should be done in the matter, although obviously local officials should be consulted.

It is also, in my opinion, very important that the interests of the community, as a whole, should be considered before that of the individual which is why I object to the proposal that our reasons for refusing requests for disforestation must always be given as a matter of principle. When such requests are made by a large section of the local community the situation is quite different and I agree that such applications must be considered very carefully; but individual applications for disforestation are, in my opinion, usually such that the community will not benefit, as a whole: they are in fact much more likely to lose by the change.

I therefore consider that it is up to the applicants to prove to the satisfaction of the authorities that disforestation is absolutely necessary in their interests, and that their claim to disforestation is so great that it should be considered before that of the community, as a whole, or alternatively that the interests of the community will not suffer by the change. If the authorities are satisfied that the applicants have a good case then it is certainly up to the Forest Department to justify their refusal of such an application, but this is a very different matter to having to justify as a matter of principle their refusal to every application received, however unnecessary such

an application may appear to be, which is, I take it, the proposal which has been put forward.

In stating the above views which are those of a fairly junior officer, I would hasten to add that they are of necessity based on a comparatively short experience of such questions, which have been gained in only one small part of the country. There may well be factors which influenced the originator of the proposal which formed the basis of Amimad Orishe's article, of which the writer has no knowledge and which may alter the whole complexion of the case. If so, it would be interesting to hear them as, not having any knowledge of these factors, the proposal that "each and every application for disforestation should be dealt with on its merits by the Forest Department which must show full justification for refusing to grant the request" does not appear to the writer to be in accordance with those principles which, we have been taught to believe, form the basis of our forest policy.

REVIEWS

PROGRESS REPORT ON FOREST ADMINISTRATION IN COORG FOR 1934-35.

The system of exploiting the Eastern forests by clear felling followed by artificial regeneration of teak was continued. About 200 acres in the Timber Working Circle which were rubbish-felled and burnt last year were regenerated during the year under report.

D

Departmental fellings were also carried out in about 275 acres in South Coorg Division. The quantity of timber obtained during the year by fellings, classification, etc., in both the divisions was 129,221 c.ft., as against 101,400 c.ft. in the previous year.

The total quantity of sandalwood sold during the year was 220 tons, as against 321¼ tons in the previous year, and the amount realised was Rs. 1,99,409, as against Rs. 2,85,313 in the previous year.

The financial results of the working of the Department were poorer than in the previous year. The total revenue fell from Rs. 4,32,344 to Rs. 3,54,418, and the expenditure rose from Rs.1,93,013 to Rs. 1,98,059. The decrease in revenue is due partly to the sale of a smaller quantity of sandalwood and partly to low prices realised for sandalwood and timber, and the increase in expenditure is due to the extraction of larger quantities of timber from outside the regular felling areas and also to the increased rates for carting to the Hunsur Depot. The profit and loss account shows Rs. 1,71,900 as profit for the year.

Experiments in connection with germination and pre-treatment of sandal and eucalyptus seed, investigation of sandal spike disease, and tests to determine the optimum season for stump planting of teak were carried out at various centres and have produced valuable results.

THE FORESTS OF BENGAL.

This book compiled by officers of the Indian Forest Service, Bengal, under the auspices of the Honourable Member Sir Abdelkerim Ghuznavi, aims at giving an "outline of the history of Forestry in Bengal, a description of the forests themselves" and an "account of the activities of the Forest Department" and we have no doubt that the authors have achieved this aim. All the main forest areas in Bengal are described and the map accompanying the book shows at a glance the distribution of various classes of forests. The easy

style in which the book is written and the various aspects of the activities of the Forest Department dealt with in it make reading interesting and instructive.

The Bengal Forest Department was started in 1873-74 with only 5 divisions (area of reserved forests about 1,467 sq. miles), while it controls at present 10 divisions with an area of 10,658 sq. miles, out of which 6,471 sq. miles are covered by reserved forests.

Although it is said in the preface that the book is intended for laymen rather than for the professional, the chapters on Taungyas, History of Silviculture in the Hills and Experiments and Research contain much valuable information useful for Forest Officers. The chapter on Sal Taungyas is particularly good and should be read by every Forest Officer. The various efforts made, the stages gone through, the eradication of climbers which have to be combated at all stages and which is still under study are most interesting points and well repay perusal. There is a very interesting chapter on "Elephants and elephant catching."

As we read the history of the forests in Atia Pargana, in Chapter VI, we find vigorous and relentless opposition made by the proprietors to the management of their forests by Government, which depicts clearly the mentality of the ill-informed agitators. This chapter will be of special interest to Forest Officers in Bihar where the procedure of taking over the private forests under the management of the Forest Department is a long-drawn affair.

To the administrator whose yard stick is the profit and loss account and to the legislator whose diatribe is yammered for the benefit of his constituency the chapter on financial results will be of great benefit. Even with the bottom knocked out of market conditions the forests contribute a soothing addition of 16 lakhs to the revenue of the Province (net profit). But while the contributions of the Forest Department to the treasury are not to be neglected, they represent only a small fraction of the benefits to the country which forestry confers, the inherent good which the Forest Department does by giving employment to villagers in the neighbourhood of the

forests, minimising the danger of floods, reducing the chances of drought and maintaining rural industries and agriculture, by properly husbanding the forests under its charge, is even greater. Unfortunately these indirect benefits which the forests under the charge of the Forest Department confer to the people have not been brought out in the book and it is here that the critic may find something to say. If investigations were undertaken to find out to what extent employment is given, one would be amazed to see to what a large number of people the forests and the industries using the forest products are giving employment. This will be an eye-opener to those who agitate against the Government policy of preservation of forests.

The book is well illustrated.

NOTES ON THE COMMON FOREST TREES OF BIHAR AND ORISSA.

By H. F. Mooney, I.F.S.

This work is said to be intended for students of the forester grade and if really suitable, the foresters in Bihar and Orissa must be a great deal better educated than foresters in Upper India. Nevertheless, efforts have been made to keep the technical terms, especially botanical terms, as few as possible and the glossary shows that this has been successfully done. Still more simplification could have been effected. There is nothing in the book about classification and hence it does not seem necessary to start with " Family ; Dilleniaceæ " and to arrange all the species under their families. In mentioning the associates of sal, it would be better to use vernacular names rather than botanical names, especially in the case of plants such as *Millettia auriculata* and *Clerodendron infortunatum* which are not described and apparently not mentioned elsewhere. The statement that the pods of *Cassia javanica* and *nodosa* are similar to those of *C. siamea* seems curious especially as *C. fistula* is also described. The statement that *Casuarina equisetifolia* does not thrive far from the

coast is scarcely accurate as it is regularly planted for firewood around Bangalore and also grows well enough in gardens in Northern India hundreds of miles from the sea. Failures inland are probably due to the absence of the root nodule organism necessary for satisfactory growth. Most people will not agree that *Artocarpus lakoocha* is very like *A. integrifolia* in general appearance.

Notes on the silvicultural characteristics of each species have been given and these show that much remains to be discovered or recorded. For instance, the rate of growth of coppice shoots of *Grewia tiliaefolia* is said to be very rapid but the size of shoots only two years old is quoted. "The rate of growth (of *Hardwickia binata*) under natural conditions is said to be distinctly slow." Data surely could be collected to prove this. Notes on frost hardiness have been given for most species and as usual they seem very erratic. Many species are said to be frost tender although they occur naturally in the Punjab and extend as far as the Indus in some cases, *e.g., Emblica officinalis, Odina wodier, Albizzia stipulata, Holarrhena antidysenterica, Holoptelea integrifolia* and others. One would anticipate that a tree which can stand the winter in the N. W. Punjab would be frost hardy in Bihar, but this apparently is not the case. There are many possible explanations, frost in a frost-hollow in Bihar may be quite as severe as it is on a hill-side in the N. W. Punjab. The damper climate of Bihar may encourage a longer growing season than the dry climate of the Punjab, etc. Each observer has his own ideas as to relative frost hardiness of plants, and observations made in one year may not agree with those made the following year even in the same locality.

R. N. P.

LORD LOVAT.

By Sir F. Lindley.

(*Hutchinson & Co.*, 1935.)

This is a fascinating book for anyone who cares for the wider implications of forestry as an integral part of the greater science of human welfare. The late Lord Lovat was an outstanding example of the type of great forest owner who values his trees for what they contribute towards human values as well for the joy of seeing a planting job well done.

He will doubtless be best remembered by foresters as the first Chairman of the British Forestry Commission. In face of considerable opposition from various vested interests and political groups the Commission's foundations were well and truly laid, largely through Lord Lovat's unbounded energy and loyal support of the staff of technical foresters who were to a great extent selected by himself. As with Brandis in India and Gifford Pinchot in the United States, the early framework of the service which each was instrumental in building up from small beginnings, was based largely upon the personality of the man in charge, and each of these three has the faculty of inspiring their new staff with some of their own enthusiasm in working towards what many considered an impractical ideal.

Lovat's work in the South African War gave him an early interest in land settlement and in the proper utilisation of land as a problem affecting the whole Empire, and this combined with his later experiences in several other colonies and in Brazil gave him a vast knowledge of working conditions. Unfortunately ill-health, resulting from his experiences in Gallipoli, prevented him from fulfilling the many projects for imperial land development which he had in view.

His work in the latter half of the Great War was as Director of Forestry to the British Forces in France, and it was largely owing to his magnificent powers of obtaining co-operation and willing work from such diverse types as Canadian lumberjacks, French forest owners, German prisoners and our own military organisation that the armies were latterly supplied with all the wood they needed. In

April 1917, the production from French forests for the British army amounted to only 50,000 tons a month, mainly round timber and fuel, and all the sawn timber was imported. During the 20 months following Lovat's appointment 3 million tons were delivered to the armies, including a million tons of sawn timber, and by October 1917, 90 per cent. of the British army requirements were provided from French forests. The total strength employed on this forestry work at the end of the war numbered some 45,000 men, 1,000 motor vehicles and 6,000 horses; this force included 11 R. E. Forestry Companies and 63 Canadian Forestry Corps Companies. During this period Lovat did much himself to bring about standardisation of timber demands and he also foresaw the need for wooden pickets for defensive measures; during March to May 1918, when the British were defending the line "with their backs to the wall" 90,000 tons of pickets were delivered to the front. Apparently none of the military quartermasters had anticipated the need for such enormous defensive supplies, or at least none had been asked for earlier, and it was on Lovat's own initiative that a large reserve of wooden pickets was built up ready for use when they were most needed in preparing fresh defensive lines during the series of German attacks in the spring of 1918.

Let us hope that the forestry profession will always be fortunate enough to secure the leadership of such great-hearted patriots as Simon Fraser, Lord Lovat.

R. M. G.

PROGRESS REPORT ON FOREST ADMINISTRATION IN BENGAL FOR 1934-35.

The very satisfactory recovery in the surplus is an outstanding feature. According to the report the surplus rose from Rs. 60,378 in 1933-34 to Rs. 2,92,523 in 1934-35. Actually the results of the year are complicated by an entry regarding interest; it would be well if this could be omitted as has already been done in some other provinces. Excluding interest the surplus of the year should be

increased by Rs. 59,851 over the above figures. On the other hand, as departmental extraction is fairly extensive, stocks of produce must be considered, the surplus increased by the stock at the close of the year being Rs. 88,204 less than at the commencement, owing largely to increased sales resulting from the work of the Forest Utilization Officer.

Outstandings of revenue which in the Forest Department can almost always be ranked as " debts considered good " are Rs. 52,629 more than at the commencement. On the above figures the real profits of the year are Rs. 3,16,799. The increase is due to the more revenue resulting from better prices and more extensive departmental operations.

The progress in the province generally could be more easily ascertained if the entries for the whole province were amalgamated in place of the detailed reports for the two Circles. This could also reduce the length of the report.

The report contains interesting details of varied experiments in silvicultural methods. Numerous indigenous and exotic species are being tried out in plantations. It is by no means easy to anticipate, in this age of substitutes, what species will be of value in, say, 50 years time and to arrange for adequate supplies. It is perhaps unduly pessimistic to suggest that sal may then no longer be used for railway sleepers, but it is at least a possibility. At present the indications are that paper-pulp production on a large scale is worth considering.

ABSTRACTS OF INDIAN FOREST LITERATURE PUBLISHED DURING APRIL TO JUNE 1936.

ANON.—*A Glossary of technical terms for use in Indian Forestry. Indian Forest Records* (*Silviculture*) *II* (1) ; 45, 1936.—The glossary of 1930 is revised in accordance with the resolutions of the fourth silvicultural conference held in 1935.—(H. G. CHAMPION.)

SEAMAN, L. N. AND V. D. LIMAYE.—*Rules for the grading of teak squares.*—This pocket book presents tentative grading rules for teak squares from Burma and South India. The rules have been accepted provisionally by the big teak firms in Burma and also by the large purchasers of teak, such as the Indian railways.—(H. TROTTER.)

RAMASWAMI, S.—*Indian woods tested for match manufacture.*—This pamphlet contains a list of Indian species which have been tested from time to time for match splint and match box manufacture, with brief reports on the suitability or otherwise of the species in question.—(H. TROTTER.)

BEESON, C. F. C.—*Martesia : A marine borer. Indian Forester, LXII*, 286-289, 1 *pl.*, 1936.—Records the importance of *Martesia striata* L. (Mollusca) as a borer of logs stored in brackish or salt water in the estuary of the Beypore river, Malabar, India. The seasonal history was determined by immersing samples of teak at intervals of a month and leaving them exposed for periods of one to eleven months. The illustration shows the rate of penetration in the active season November to June. When the monsoon flood waters come down in June the borers in floating logs are killed and the free swimming population disappears. Measures are suggested for handling logs in safety during the danger period.—(AUTHOR'S ABSTRACT.)

LAL, J. B.—*Constituents of the seeds of Blepharis edule. Journ. Ind. Chem. Soc.* 13 ; *p.* 109, 1936.—The seeds, a common Indian medicine, have been found to contain a glucocide, Blepharin ($C_{16}\ H_{20}\ O^{11}$) and a tasteless nitrogenous substance, allantoin (C4 H6 O3 N4).—(T. P. GHOSE.)

KRISHNA, S. AND B. S. VERMA.—*Active principle of Nyrisine apricana, Linn. Journ. Ind. Chem. Soc.* 13; *p.* 115, 1936.—Like the berries of *Embelia ribes*, the berries of this species are also used in Indian medicine as an anthelmintic. These have been found to contain d-quercitol and embelia acid (the active principle of *Embelia ribes*).—(T. P. GHOSE.)

EXTRACTS

FOREST PRODUCTS RESEARCH

The seventh report of the Forest Products Research Board, in which details of the work of the Forest Products Research Laboratory, undertaken in the year 1934, are set forth, has now been published. An appendix contains a Report to the Standing Conference on Timber Utilization on the Investigation of Empire Timbers for the year 1934.

General Programme of Work.—Marked progress has been made in the investigation of the relation between the structure and the technical properties of wood. In connection with woodworking and seasoning tests, an abnormal condition of the fibre walls has been found to affect the machining properties and seasoning qualities of certain timbers. The phenomenon will be further investigated. Chemical analysis of matched samples of timber has been carried out with the object of determining whether any direct relation exists between variations in the chemical composition and the technical properties of the timber.

Progress has been made in the study of the moisture relations of wood in the neighbourhood of the fibre-saturation point. The results of research on Sitka spruce wood flour have thrown doubt on the generally accepted values of the so-called fibre-saturation point.

The apparatus for the photo-electric measurement of the cell-space ratio of woods has been modified with a view to simplifying the technique, and has now been permanently set up in a new dark laboratory. The modifications are such as to render valve amplification unnecessary. An account of the method has been published.

The connexion between the amount of shrinkage of wood during drying and subsequent expansion, contraction or distortion caused by variations in atmospheric conditions has been a subject of further study. The relations between the moisture content of wood and the surrounding hygrometric conditions have been investigated and a chart intended to serve as a general indication of the moisture contents to which timber should be seasoned to suit various environments has been prepared.

Seasonal changes in the moisture content of more than 50 species of timber kept under various conditions have been recorded.

An electrically operated instrument for the rapid determination of the moisture content of wood, based on a design originally developed at the Forest Products Laboratory, Madison, has been constructed and its value is being investigated.

A series of kiln-seasoning experiments on stocks of timber in special dimensions has been carried out. Heat losses in kilns have been studied with a view to the more economical operation of artificial seasoning plants. The variations in the drying rates in the different types of kilns and the relative advantages and disadvantages of autumn piling and spring piling of stocks of timber for air-seasoning have also been under investigation.

Research on the bending qualities of various timbers has progressed satisfactorily and it has been shown that high pressures in the steaming process, preliminary to bending, may be detrimental to the wood. It has been found that certain ebonies (*Diospyros* spp.) from Nigeria respond very satisfactorily to bending treatment. Tests to determine the stress-strain relations of steamed timbers both in tension and compression have been carried out and have proved of considerable value in making a rapid estimation of the bending qualities of any particular timber.

The scope of the investigation of the strength properties of timbers in structural sizes has been widened to embrace the entire range of structural timbers used in this country. The Timber Trade Federation of the United Kingdom has evinced a keen interest in this phase of the work and co-operated to the extent of defraying the cost of certain of the consignments which have been tested. Information concerning the strength properties of many commercial timbers has been accumulated and standardised values for these are now available for reference.

In the development of a technique for determining the resistance to abrasion of timbers the stage has now been reached at which the results obtained in the machine specially designed for the work are similar in many respects to those observed in timber in actual service, but further trials will be carried out before the present methods of test are finally adopted as satisfactory. The final stage of the work will consist of the definition of the various types of failure and the adoption of standard criteria of serviceability.

It was decided to establish a box-testing laboratory and to install a tumbling drum, a crushing machine, and auxiliary equipment. The services of this laboratory are now available.

The investigation of the strength properties of ash affected by decay due to *P. hispidus* has been completed. The results show that the toughness of ash is seriously affected at an early stage but that other strength properties are reduced more slowly.

A study of the effect of various insecticides on glues used in the manufacture of plywood has begun, and tests have been undertaken to obtain information on the subject. The results will be of value to the plywood industry.

The project under which standard tests of wood preservatives are made has been amended to admit of tests of preservatives intended for dipping treatments or for brush application. Previously, standard pressure treatments only were used in investigating the efficacy of wood preservatives. Tests on thirty different preservatives, using a standard dipping treatment, have been started.

The four main railway companies and the Forestry Commission have co-operated with the laboratory in an investigation which has for its objects the testing of the suitability for railway sleepers of certain species of timber grown in the British Isles, and the production of a treated sleeper which will have a life at least as long as those previously employed, while costing less. 4,400 sleepers have been treated in various ways and these will be laid in railway tracks at eight different sites and a record of their behaviour will be made. Work on the nature of creosote extracted from old creosoted timber has been continued, and the results have been published.

A standard method of testing certain aspects of the natural fire resistance of various timbers, using relatively small specimens, has been evolved. Such small-scale experiments cannot compare in value with those made on complete structural units, but they are useful as a means of showing which species possess sufficient resistance to fire to justify the expense entailed in carrying out trials on a full scale.

Satisfactory progress in the study of the factors determining the susceptibility of timber to infestation by *Lyctus* Powder-post beetles has been made, and new facts concerning the food of the beetles have been brought to light as the result of the chemical and biological work which has been done. Further information regarding the factors affecting the emergence and flight of insects and methods of control has been accumulated.

The results of biological work on the Death-watch beetle (*Xestobium rufovillosum*) have clearly demonstrated that the life-cycle of this species may be completed under favourable conditions in a much shorter time than was formerly supposed. It has been found possible to rear the insect from the egg in the Laboratory, and this opens up possibilities of rearing large numbers of insects, which will facilitate investigations of the type and extent of fungal decay in timber in relation to the development of the insect, and of methods of control.

A further study of the effect of heat treatment for the destruction of the Common Furniture beetle (*Anobium punctatum*) has been in progress with satisfactory results.

The temperature relations of further species of fungi which attack wood have been determined. A paper containing the results which had previously been obtained in work on a number of important species was published during the year. A chemical investigation of the effect on oak heartwood of the fungus responsible for the production of "brown" oak has been undertaken. The results so far achieved suggest some action by the fungus on the tannin in the wood, but there is also evidence that the major wood components may be affected.

Tests of the strength properties of "brown" oak tend to indicate that the action of the fungus is slow in affecting the strength properties in the early stages of infection.

Experiments to determine the relative efficacies of various chemicals used in dip treatments for the prevention of stain in timber caused by fungi have been in progress during the year. These are of considerable economic importance, as the annual loss to timber merchants through the action of stain-producing fungi is appreciable.

Laboratory and field tests of the natural durability of various timbers have been continued, and under this project an investigation of the relative durability of timber, cut from logs of oak and beech previously stored under sea water, has been initiated.

Work in connection with the effects of chemical reagents on wood has been continued, and further progress has been made in the study of the composition and properties of the hemicelluloses of the wood of English oak. Results of an investigation of hemicellulose have been published.

Utilization work connected with grading, mining timber, turnery and the utilization of thinnings has proceeded, and a study, in co-operation with the Forestry Commission, of the types of saws used in pruning and the effect of pruning on the quality of the timber obtained from pruned trees has been undertaken.

During the year applications for one major, seven preliminary and four special tests of Empire timbers were considered and accepted. Full details of the progress made during the year in the test work on, and practical trials of, 28 Empire timbers are given in Appendix II to the Report of the Forest Products Research Board for the year 1934.—(*Report of the Department of Scientific and Industrial Research, London, for the year* 1934-35.)

THE INFLUENCE OF AGRICULTURAL CROPS IN TAUNGYA PLANTATIONS ON THE GROWTH OF TEAK

BY DR. IR. CH. COSTER AND M. S. HARDJOWASONO.

(*Summary.*)

Sample plots, consisting of mostly 5 parallel series of 6 different kinds of agricultural crop, were laid out on 4 different places, on different soils of medium quality. The following differences were studied :

(1) taungya without agricultural crop,

(2) with dry rice,

(3) maize,

(4) cassava,

(5) dry rice, whilst the teak-rows were shut in by a double row of *Leucaena glauca*,

(6) other crops, *e.g.* peanuts, goat-pepper or alternating dry rice and maize.

Only one crop was allowed, which was planted together with teak and *Leucaena* in November 1933 and harvested after 3—6 months. In Deling, the first crop was followed by a second crop of maize. The harvest of the crops is in most cases rather good.

The growth of tea was measured in March 1934 after 4½ months' growth, during the dry monsoon in August 1934 and in February 1935. The following conclusions may be drawn :

(*a*) Each agricultural crop sets back the growth of teak. A succession of more agricultural crops is more harmful than only one crop.

(*b*) The difference in height of the teak in the blocks without any agricultural crop and the other blocks increases still during a short time after the harvest. Afterwards it remains about the same, so that the procentual difference diminishes rapidly by increasing height.

(*c*) Cassava is a very harmful crop. The other crops are more tolerant, in the order of : cassava, dry rice, maize and peanuts, goat-pepper.

The shutting in of the teak row by two rows of *Leucaena* is also harmful.

(*d*) The damages of the *taungya* system are not so great that it should be abandoned, because of the many and great advantages above all other systems of teak-cultivation. In some cases, the agricultural crop might be limited to one harvest only.—(*Tectona*, June 1935.)

[It is evident from these results that the forest officers concerned in raising teak in *taungya* plantations will have to work out the retarding effects of the various field crops and under varying conditions. It must also be remembered that these retarding effects may not only be due to root competition but also due to other factors such as shade. In the above experiments it is possible that shading which is greatest in Cassava—a crop which has proved to be most harmful—may well be the influential factor rather than root competition.—HON. ED.]

SYNTHETIC ANTI-MALARIALS

BY W. O. KERMACK, M.A., D.Sc.

Research Laboratory, Royal College of Physicians, Edinburgh.

Malaria is one of the major destructive diseases attacking the human race. In India alone, it is reckoned that 80—100 millions out of 370 millions contract this disease every year. Amongst the vast populations of south-eastern Asia as well as of the continents of Africa and America it exacts its heavy toll. The fight against it is carried out on many fronts. Control of the disease is attempted by measures directed against the mosquito, which, as everybody now knows, is the carrier conveying the disease from man to man. The drainage of land in order to remove suitable breeding places and the oiling of ponds and lakes so as to destroy the mosquito larvæ are amongst the measures taken by public authorities in many countries, whilst personal precautions, designed to minimise the number of mosquito bites, are taken for granted as but prudent common sense in malarious regions. With all this work the name of Sir Ronald Ross will always be associated.

But in recent years a vigorous attempt has been made to attack the malaria problem from a new angle. The efficiency of quinine as a specific drug against malaria has been known to Western Europe since the seventeenth century. It is in the large majority of cases really efficacious and its use is widespread, but even so it has certain important drawbacks. Large doses are required over considerable periods and this not infrequently gives rise to disturbing and even alarming toxic symptoms. Occasionally, where an extreme degree of sensitiveness to the drug seems to exist, these untoward effects may be so severe as to exclude the use of quinine absolutely. Though relatively cheap, the quinine alkaloids are still too dear to allow of their free use by the poverty-stricken multitudes amongst whom the disease is so rampant. The cure of the symptoms, which may be effected within a few days, is often followed by a relapse when the treatment is stopped, and this is particularly unfortunate where economic reasons prevent the patient being kept for more than a few days away from work, or even under medical observation. It is not surprising, therefore, that in this age of synthetic Organic Chemistry, attempts should have been made to manufacture compounds more or less closely related to quinine, in the hope of obtaining a drug with all the efficiency and none of the disadvantages of the natural alkaloid. The search has been a long and difficult one. The problem is complicated because the malarial parasite has curious and complex ways. There are three distinct types of parasite, sub-tertian, benign tertian and quartan, and each type goes through an

elaborate life cycle assuming various forms in the mosquito and in the human host. What is really wanted is a drug which will attack each of the forms of each of the parasites with complete and certain effect and at the same time be so specific as to leave the tissues of the host quite unharmed. Four lectures were delivered by Dr. Green in May 1934 at the course on Malariology at Singapore under the auspices of the League of Nations and give a very interesting and valuable account of the progress so far made.[1] Naturally they are concerned in the most part with the two synthetic anti-malarials which have become best known during the last ten years, namely, plasmoquin and atebrin. Both of these are the result of prolonged research carried out by the Bayer Co. at Elberfeld.

Plasmoquin, it would seem, has not fulfilled its early promise. In the case of quartan and benign tertian malaria it is doubtful whether it has any advantage over quinine.

Atebrin, on the other hand, would seem to be in almost every way as effective as quinine and to be definitely superior in reducing the number of relapses. Being a relatively new medicinal it is doubtful whether the optimum conditions for its use have yet been completely ascertained. Even as it is, serious toxic effects would seem to be quite rare.

For the treatment of the great malarial-stricken masses of the tropical and sub-tropical regions of the world a drug is required which is very cheap, very efficient and very safe. Nothing so far known quite meets all requirements but the development of active synthetic compounds clearly points to the possibility of still better ones being obtained if only sufficient energy and money is given to the problem. It is stated that 12,000 different compounds were prepared and tested by the I. G. German chemical combine in the course of the development of plasmoquin and atebrin. This indicates the magnitude of the effort which is required. But the objective is one of world-wide importance and it is to be hoped that the resources of Medicine on the one hand, and of Chemistry on the other, will be combined in ever-increasing efforts to solve successfully this grave and important problem.—(*Science Progress*, January 1936.)

---

[1] "Lectures on the Development and Use of Synthetic Anti-malarial Drugs." By Richard Green. [Pp. 50.] [Bulletin from the Institute of Medical Research, Federated Malay States.]

The following information is extracted from the *Seaborne Trade and Navigation of British India*, for June 1936—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of June			Month of June		
	1934	1935	1936	1934	1935	1936
Wood and Timber				R	R	R
Deal and pine wood.. cubic tons	1,116	1,256	815	69,092	79,598	45,524
Teakwood—						
From Siam .. cubic tons	1,169	..	70	1,01,150	..	9,996
" Indo-China "	..	..	76	..	..	8,902
Total .. "	1,169	..	146	1,01,150	..	18,898
Sandalwood .. .. "	74	12	23	22,941	6,421	8,054
Other kinds of wood and timber, including firewood, timber for match-making and plywood, etc. "	..	..	..	1,58,964	1,67,776	1,26,603
Manufactures of wood, including wood-pulp and tea-chests *other than* furniture and cabinetware .. "	..	..	..	9,09,599	8,71,718	3,24,147
Total ..	..	..	..	10,91,504	10,45,915	4,58,804
Total of Wood and Timber "	..	..	..	12,61,746	11,25,513	5,23,226

EXPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of June			Month of June		
	1934	1935	1936	1934	1935	1936
Wood and Timber—						
Teak wood—				R	R	R
To United Kingdom, cubic tons	1,654	4,727	2,515	3,99,174	9,24,253	5,12,620
,, Germany .. ,, ,,	224	922	401	53,028	2,12,881	99,678
,, Belgium .. ,, ,,	34	80	100	6,579	15,248	15,423
,, Iraq .. ,, ,,	107	100	51	25,043	16,416	6,350
,, Ceylon .. ,, ,,	5	28	..	603	3,080	..
,, Union of South Africa .. ,, ,,	460	297	826	1,02,344	47,216	1,75,293
,, Portuguese East Africa .. ,, ,,	30	128	167	5,662	23,666	28,422
,, United States of America .. ,, ,,	4	86	23	975	21,552	5,556
,, Other Countries ,, ,,	283	342	1,321	61,116	72,226	2,87,722
Total .. ,, ,,	2,801	6,710	5,404	6,54,524	13,36,538	11,31,064
Share of Bengal ..cubic tons	..	..	..	..	..	..
,, Bombay .. ,, ,,	173	140	46	44,087	28,091	9,782
,, Sind .. ,, ,,	..	..	..	106	..	..
,, Madras .. ,, ,,	7	10	..	815	2,814	..
,, Burma .. ,, ,,	2,621	6,560	5,358	6,09,516	13,05,633	11,21,282
Total .. ,, ,,	2,801	6,710	5,404	6,54,524	13,36,538	11,31,064
Teak Keys .. tons	431	707	383	61,645	1,02,725	57,525
Hardwood (*other than* teak) and manufactures of wood *other than furniture and cabinet-ware* .. Total ..	..	..	..	44,924	55,826	41,959
Sandal wood—						
To United Kingdom .. tons	..	..	..	..	..	..
,, China (*excluding* Hong-Kong) .. ,,	8	..	3	12,820	..	4,550
,, Japan .. .. ,,	2	13	5	2,637	13,413	6,000
,, Anglo-Egyptian Sudan ,,	4	8	2	4,810	8,410	3,050
,, United States of America .. .. ,,	55	..	52	63,500	..	51,600
,, Other Countries .. ,,	..	3	1	1,375	3,982	602
Total .. ,,	69	24	63	85,142	25,805	65,802
Total of Wood and Timber and Manufactures thereof ,,	..	..	..	8,46,235	15,20,894	12,96,350

VOLUME LXII 667 NUMBER 11

INDIAN FORESTER

NOVEMBER, 1936

THE HAILEY NATIONAL PARK

BY E. A. SMYTHIES, I.F.S.

In the spring of 1934, Sir Malcolm Hailey, at that time Governor of the U. P., suggested that the Forest Department should make proposals for the creation of a game sanctuary or national park, on the lines recommended by the International Conference of 1933, *i.e.*, a national park to be created by legislative authority. An area of about 150—200 square miles was suggested, and the writer was asked to make concrete proposals for a suitable area within the reserved forests of the Western Circle.

2. The locality *par excellence* for such a park is the famous Patli Dun, and the hill forests to the south of it. Nearly 20 years ago I wrote a descriptive article of the Ramganga valley and the Patli Dun, which form, roughly, the northern boundary of the park. It will give a good indication of the type of country if I quote some extracts from that article :—

" The river debouches from the foothills of the Himalayas into the flat Bhabar country in a wide stony bed, surrounded on either side by thick scrub forest and broad bands of heavy grass, the home of uncounted deer and carnivora. A small bungalow and two or three grass huts installing peripatetic banias represent the last outpost of civilisation and of shops. Thence, for 8 miles upstream, the river has broken its way through the last rampart of mountains in a precipitous and lonely gorge, where great slabs of bare yellow sandstone and vertical rock strata alternate with deep-sided ravines dripping with moisture and covered with maidenhair ferns, and all manner of tropical creepers and orchids clinging to the dark evergreen forest trees. Through this gorge flows the river, now with its voice hushed in a long deep mysterious pool, now foaming over boulders in a

roaring cataract where the big mahseer lie to feed, or again swirling with a subdued mutter past occasional sandbanks or half-submerged rocks where the crocodiles love to bask, and everywhere we find the foot-marks of sambhar and of the little red kaikar, which come down at dusk to drink, and the more occasional pugs of tiger and leopard and wild dog which lie in wait or catch and kill their prey by the roar of the great waters.

" Above this gorge, the character of the river alters, and the most perfect part of this most perfect river commences. Imagine a broad flat valley of old river terraces, two to three miles broad and fifteen miles long, covered for the most part with great seas of waving tiger grass, with occasional islands of sal and scattered trees of dhak and semal, and along the river itself dense thicket and islands of shisham. To the south, a low scarp of hills, sloping down into the grassy savannah in broad sheets of dense sal forest ; to the north, a higher ridge of hills, rising 2,000 feet above the river level, clothed from top to bottom with the luxuriant tropical forests, and broken up into a wild medley of little side ravines and ridges. Meandering down the valley, sometimes on one side, sometimes on the other, flows the river between broad beds of boulders and sand, and bordered by tufty grasses and shisham thickets. No longer we find the unfathomable pools and wild grandeur of the gorge, but the river flows crystal clear, quiet and sparkling, over broad stretches of gravel, ending in a short stretch of rapids running into a pool which again tails off into a broad reach of gently flowing water. No longer we find the monsters of the gorge, but the water swarms with their smaller brothers, running from one to eight, or occasionally ten, pounds.

" In the early spring the almost sacred beauty of the spot keeps one perpetually enthralled. At that time of the year the grassy savannahs have been burnt and replaced by broad expanses of vivid young green, which match the still more vivid green of the budding shisham thickets and form a wonderful contrast with the dark sombre green of the sal. Add to this the blazing scarlet flowers of the " Flame of the Forest " (the dhak) and the paler orange red of the flowers of the semal, with the dull dark crimson of the Indian sumach, the pure blue

sky above, and the sparkling blue waters below, and we have such a riot of harmonious colouring and a purity of scene that surely cannot be equalled, or at least excelled, anywhere on earth.

"But the crowning glory of this most glorious valley is its absolute wildness, where wild elephants wander freely, and tigers roam at will. Hidden away in the depths of leagues of primeval forest, an occasional forest chauki or still more occasional rest-house are the only signs of human habitation; not a village or hamlet in all this stretch spoils its virgin wildness.

"Here, as nowhere else, nature is unspoilt by contact with man, and the methods and manners of the beasts of the forest can be studied intimately and at first-hand. When the chaors are burnt, and the young grass comes up, the eaters of grass, the chital, parha and karkar, come out in the dusk to graze from the shady sal forests and shisham thickets where they have laid up in the day.

"Naturally the eaters of flesh, who prey on the concentrated herds, are concentrated in this area also. The hours of darkness and more especially the hours of dusk, soon after sunset, ring to the melodious danger call of the chital, the harsh bell of the sambhar, or the persistent bark of a karkar, which has spotted the slinking form of a leopard or perhaps a tiger stalking down boldly for a drink. More rarely (but yet not so very rarely if one is lucky), the feline is met with hunting his meat from God, and once in the gloaming the writer stood absorbed and unobserved, watching a tiger stalk a herd of chital to a successful conclusion. This also is the breeding season of the chital and the hoarse screaming challenge of the chital stags adds a note of indescribable appeal to the voices of the forest. Moving quietly along the edge of the forest, it is no uncommon sight to see two stags with clashing antlers and striving quarters fighting for the possession of the admiring herd.

"Gradually the valley closes in, and again the river is running in a narrow precipitous gorge, even grander and more inspiring than the lower one, with tier upon tier of densely forested slopes rising up steeply a thousand feet above the river level. Here again the river flows with great foaming rapids running into deep cavernous overhung

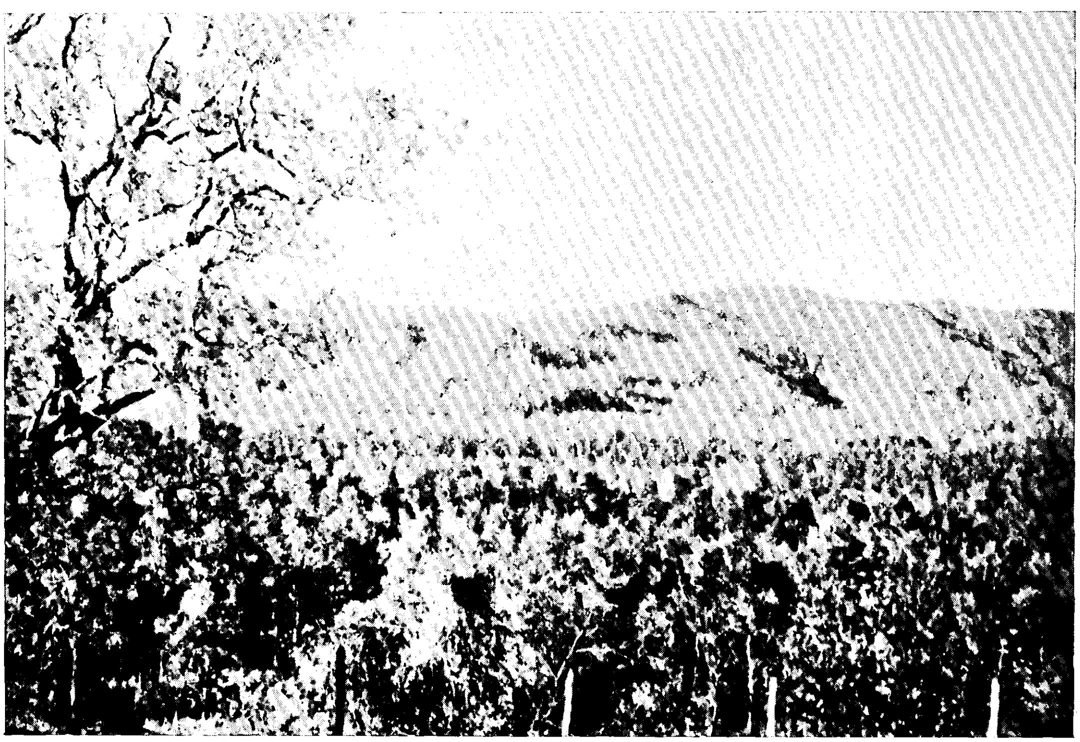
pools. For over 30 miles the river and its valley affords a tract of glorious country to the sportsman and naturalist, to the artist and lover of wild nature, that, once known, can never be forgotten, and its haunting memory ever strives to draw one back to the infinite charm of so perfect an environment."

To the south of the river we find a wild and broken tangle of hills and streams, more than 120 square miles in extent, the natural home and breeding grounds of tiger, and with untold numbers of sambhar and chital, limited only by the carnivora. A solitary touring road, connecting a line of forest rest-houses, and an occasional fire-line are the only permanent signs of human activities, and there are no villages or village cattle.

3. In this ideal locality it was decided to create the national park. The first proposals included a total area of nearly 170 square miles, but the area finally accepted totalled about 125 square miles. The next step was to draft a Bill, believed to be the first of its kind in India, for consideration of the local Legislature. The United Provinces National Parks Act, 1935, was finally passed by the Legislative Council in February 1935, and received the assent of the Governor of the United Provinces in March 1935, and of the Governor-General in April 1935. Its provisions are very wide. For example, " animal" is defined as " any mammal, reptile (excluding snakes, except python) or bird," and it is an offence " to kill, injure, capture, or disturb any animal or to take or destroy any egg or nest of any bird." Again, the conditions under which a person may enter or reside in the Park are laid down, and a permit has to be obtained beforehand, except in the case of officials and forest contractors. Photography is permitted, but no flashlight apparatus may be taken into the Park.

4. The only criticism that has been made regarding the Hailey National Park is that it is inaccessible to the general public. This is, however, receiving careful attention. Since the Park was created, fair weather roads for light motor traffic have been opened up, connecting the Park with the Bareilly—Naini Tal road and railway on the east, while within the next 2 or 3 years, similar fair weather roads will be completed (*i*) connecting the Park with Hardwar and Dehra

THE RAMGUNGA GORGE (*Copyright reserved by author.*)



VIEW IN THE PATLI DUN (*Copyright reserved by author.*)

A SAMBHAR STAG IN THE HAILEY NATIONAL PARK

(Copyright reserved by author.)

TWO SAMBHAR HINDS IN THE HAILEY NATIONAL PARK

(Copyright reserved by author.)

Dun on the west, (*ii*) completely encircling the Park, and (*iii*) a motorable road for 30 miles through the centre of the Park.

Some visitors have expressed surprise that the animals are not tamer or less shy than they appear to be at present. The Park, however, has only been in existence for a little over a year, and in the Kruger National Park of South Africa it took 25 years of closure before the wild life became really tame! The two snapshots of sambhar (a stag and two hinds) which illustrate this article were, however, taken at a range of a few yards, without a telephoto lens, and suggest that the animals are not so very wild after all. And on a number of occasions, when wandering on foot or on elephant, the writer has met tigers roaming about in the day-time.

The Park, combined with the amenities for fishing on the northern boundary, has already attracted visitors, and at one period last hot weather the Governor of the Province, the Army Commander, and a Commissioner, were present at the same time and occupied most of the available accommodation. If or when the Park becomes better known, and more accessible, the question of extra accommodation for visitors will require consideration.

[NOTE.—We should be very glad to have similar articles on any other National Parks or sanctuaries that have been formed. The copyright of the photographs is retained by the author whose permission should be obtained before reproducing them.—ED.]

AFFORESTATION OF THE RIDGE AT DELHI

BY R. N. PARKER, I.F.S.

In January 1920, an article on the above subject appeared in the *Indian Forester*. As I have been able to revisit the Ridge some 16 years later, a few notes on the results obtained may be of interest.

As foretold in my previous article, most of the work of the first few years was entirely wasted. About half the species planted have died and the remainder have only persisted in favourable places, *e.g.*, *Millingtonia hortensis*, *Tecoma stans*, *Thevettia neriifolia*, *Albizzia lebbek*, *Leucaena glauca Pithecolobium dulce*, *Pongamia glabra* and *Dalbergia sissoo*. The last named has done very much better than one would have expected under such unfavourable conditions, but is not a species to choose for shallow rocky soil.

In the afforestation area the plant most used has been *Prosopis juliflora*, which has done well, but is stunted on very shallow soil. More than one form of this species has been used, one being evidently better suited to the conditions than the others, since it has started to regenerate, whereas the other forms show little tendency to do so. If any further work is done seed of this form should be selected. The most promising tree species planted is *Acacia ferruginea*, which has done well as a road-side tree on shallow rocky soil. *Albizzia amara* and *Acacia catechu* have done well and so has *Ailanthus excelsa* in places. *Acacia arabica*, which has been tried on a fairly large scale, is useless on shallow, rocky soil. *Acacia modesta* has been satisfactory, but possesses no advantages over the indigenous *Acacia senegal* which has been used on a smaller scale. *Dichrostachys cinerea* has been planted fairly freely and *Azadirachta indica* and *Butea frondosa* have been increased mainly by direct sowing amongst thorny bushes. *Kigelia pinnata* has done better than many species tried and is worth growing in the better places, as are also various species of eucalyptus. Eucalypts appear to have done well in the following order: *E. crebra*, *E. microtheca*, *E. bicolor*, *E. rostrata* and *E. tereticornis*, but the numbers planted are insufficient to give satisfactory results as to their relative merits. Two specimens of *Grewia flavescens* do not appear to have started to spread naturally as yet. A few *Cryptostegia grandiflora*, *Acacia farnesiana* and *Mimosa rubicaulis* and *hamata*, both probably planted by mistake for *Acacias*, and *Agave wightii* complete the list of plants noticed, except for a single specimen of *Acacia latronum*.

As a result of protection the indigenous vegetation has recovered remarkably and in places forms dense thickets. Even *Dichrostachys cinerea* and *Anogeissus pendula*, which were believed to be extinct or nearly so, are now becoming common in places.

There is little scope left for further work except planting or sowing of *Prosopis juliflora* on the worst places where little is coming up naturally. The planting of the better kinds of trees in selected spots, *e.g.*, *Acacia ferruginea*, *Azadirachta indica*, *Mitragyna parvifolia*, *Holoptelea integrifolia* and *Ailanthus excelsa* is advisable with the object of obtaining some real tree growth.

PUNJAB EROSION CONFERENCE

BY R. MACLAGAN GORRIE, D.SC.

On 2nd July a conference was held at Simla to consider ways and means for effecting erosion control. It was presided over by His Excellency Sir Herbert Emerson, and was made up of the Revenue Member, the Financial Commissioner for Development, three Commissioners of divisions, two Deputy Commissioners, a representative of the Finance Department, a Chief Engineer of Irrigation, the Chief Conservator of Forests, Conservator, Eastern Circle, and the Forest Research Officer. The last mentioned was included because, since April 1936, soil erosion has been made a major item in the Punjab Forest Research programme.

This conference was the outcome of the Punjab Erosion Committee's Report of 1932, but actually that Report was not referred to during the proceedings at all. An astonishing advance has taken place in the official recognition of erosion as being a major problem in the economic life of the province in these 4 years. In 1932, several members of the committee had first to be persuaded that there was a problem, but in this larger and more influential gathering the seriousness of the problem was taken for granted and the chief preoccupation was how it could be met.

The districts in which erosion is serious were discussed in turn and progress, if any, reviewed. The only area in which a forest officer has been employed solely in such work is Hoshiarpur, and here results have been most satisfactory. The inhabitants have had the 30-year-old closures of the Chos Act constantly before them to show the beneficial effect of grazing closures, and latterly several villages have been earning very large sums from selling grass cut from such closed areas. During the last two years an I. F. S. officer has been working with the Civil authorities in encouraging further closures, and in this way some 60,000 acres on the Katardhar (the outer slope of the Siwalik range) have been closed. In Hoshiarpur there still remains the inner slope of the Sawan Dun between the Siwaliks and the higher hills, where there is a great field for further work, not only in grazing

control but in improving the standard of field cultivation, which is here responsible for tremendous soil losses. Both these items are to be taken up in an erosion control demonstration in the Sawan Dun.

The only other civil district in which any work of this nature has been done by forest officials is Gurgaon, where 8,000 acres of closures have been obtained by allowing a liberal remission of revenue for any village that arranged a grazing closure in its *shamlat* (common grazing) lands. Now that the value of such closures has been established in this district, it is hoped to extend them to a much larger area, and a smaller remission should now be sufficient to bring other villages in. The conference decided to extend the Hoshiarpur activities to the Ambala district, which also comes under the Chos Act, and which is probably suffering just as seriously from denudation and loss of culturable land through gullying of the slopes and the dumping of sand on the flat lands of the lower cho beds. Much help should be forthcoming from the Co-operative Branch if the conference's recommendation is carried out for a special staff of five inspectors to be posted to Hoshiarpur district to obtain the villagers' consent to further closures.

In the Kangra district the situation is even more serious, but unfortunately the Chos Act does not apply here and the original forest settlement was so complicated and so unnecessarily liberal that legal control of grazing in all except a few forest reserves is practically nil. The possibility of developing the Kumaon *panchayati* forest conservation was considered and should be feasible, but unfortunately all concessions have already been handed out and Government has got nothing left to bargain with in Kangra except the right to spontaneous tree growth on certain classes of land. The economic pressure is so severe that the process of denudation of grazing lands is already a good 50 years further ahead in Kangra than it is in Kumaon. Short of restrictive legislation, which Government will not at present contemplate, the improvement of fodder supplies and the conservation of the much overworked common grazing can only be achieved through persuading and educating the villager. Actually the fodder position is so acute in most of the

Kangra district that many villages are prepared for the first time to ask for help in effecting closures, and the time is now ripe for such work.

An I. F. S. officer is also to be attached to the Rawalpindi civil division for propaganda work in Gujrat, Jhelum and Shahpur districts. A project for demonstrating erosion control in one of the most destructive Salt Range torrents was also recommended for the allocation of funds. In this an endeavour will be made to tackle the whole catchment of the Sauj torrent from all possible angles of control. These will include afforestation to improve the catchment value of existing forest cover, "gully-plugging" with small stone bunds in the head of each branch nala where vegetation has been completely destroyed, and the partition to individual right-holders of degraded unclassed forest for the proper terracing of cultivable areas and the better conservation of fodder on the remainder. The most notable contribution to erosion control throughout the whole province up to date is undoubtedly the partition of hill *shamlat* in certain parts of the Jhelum Salt Range, where the demand for land by "land-hungry" villagers has led to an amazing transformation; individual allotments of degraded *shamlat* slopes have been turned from dangerously eroding gullies into fertile terraced fields by the building of stone walls or contour ridges of ploughed earth. It is proposed to extend this method to unclassed forests so overburdened with rights that the ordinary regime of passive forest protection has failed dismally to conserve the natural resources of soil and fodder. Demonstrations of stream-side reclamation of cultivable land now threatened by floods, better cultivation methods, and gully-plugging to save eroding fields, will also be taken up in the agricultural areas adjoining this torrent training project.

All this development will of course entail a considerable expansion in Forest Department work which cannot be expected to produce cash returns. The department is now strictly limited in its expenditure of funds on such work, being still nominally working to the "7/10 convention," under which it must aim at making 10 of revenue for every 7 spent. This was discussed by the conference and a

recommendation was made for the exclusion from the ordinary expenditure schedule of approved unproductive expenditure on projects such as erosion control.

The question of the Uhl valley was considered by a small committee. This area consists of 150 square miles of steep hills which form the catchment of the Jogindarnagar hydro-electric power plant, which already supplies many areas with power, and will eventually supply almost the whole of the province. The winter level of the river has shrunk this year to a new record low level, below the minimum now required, and the engineers have asked for a stricter protective regime to be enforced which will reduce the very heavy seasonal grazing of immigrant sheep and goats, and improve the cultivation which is of the most primitive "shifting cultivation" type and is responsible for exceedingly heavy soil losses. Such deterioration is of course cumulative and affects adversely the perennial and sustained water yield which is now so important a factor in the industrial development of the Punjab. The position is by no means hopeless and can be saved, provided strong action is taken in arresting further denudation, but this will probably entail special legislation somewhat along the lines of the Public Utilities Bill in Britain, which empowers the authorities to acquire land and rights attached to it where these interfere with the management of the land for the public good. A further report has been called for from a sub-committee consisting of the Commissioner, Jullundur, and Conservator, Eastern Circle.

PORCUPINE-PROOF FENCING

BY E. C. MOBBS, I.F.S.

Porcupines have always been a source of damage to forest nurseries and plantations in the United Provinces, but it has not been till comparatively recent years, following the large extension of concentrated artificial regeneration, that they have assumed a position of

major importance. Fencing, usually of ordinary "rabbit wire," often in conjunction with deer-proof fencing, has been erected against them, but with very varying success. The porcupines penetrate the fencing, either by burrowing under it, climbing over it, or by biting the wire and cutting their way straight through it.

An experiment was, therefore, carried out by the Silviculturist, United Provinces, (commenced in 1932 by Mr. F. C. Ford Robertson, and continued from 1932 to the beginning of 1935 by the writer), to determine the minimum specifications for an effective porcupine-proof fence.

Four factors were considered—

(*i*) The gauge of the wire.

(*ii*) The mesh of the netting.

(*iii*) The height of the fencing above ground.

(*iv*) The depth of the fencing below ground, or the width of "layering" of the wire on the ground.

Twelve plots, each approximately 40′ square, were laid out in a blank area adjoining the Lakhmanmandi teak plantations in the Haldwani Division. These were fenced to include the following variants:

Gauge and mesh of wire—

Gauge 18, Mesh $1\frac{1}{2}''$ (2 plots).
,, 19, ,, 1″, $1\frac{1}{2}''$ (2 plots), 2″ (2 plots).
,, 20, ,, $\frac{3}{4}''$ (2 plots), 1″ (2 plots).
,, 22, ,, $\frac{3}{4}''$

Vertical height above ground—

18″ (3 plots), 21″ (2 plots), 22″, 23″, 24,″ 25″, 26″, 27″, 28″.

Vertical depth below ground—

8″, 9″, 10″, 11″, 12″, 13″, 14″. (Total—7 plots.)

Horizontal layering outwards on surface of ground—

15″ (2 plots), 18″ (3 plots).

As a bait for the porcupines *semal* (*Bombax malabaricum*) cuttings were planted in the plots, about 225 per plot at $2\frac{1}{2}' \times 2\frac{1}{2}'$ spacing, during the rains of 1932. Since they were put out very late, development was poor in the first year, and there was no porcupine damage at

all during the cold weather of 1932-33. In the rains of 1933, the *semal* developed very well, and after the rains of 1934 the plants were 3′ to 10′ high, and exceptionally up to 20′.

Porcupine damage commenced in October 1933, when two plots, with wire 19 gauge, 1½″ and 2″ mesh, respectively, were entered by cutting of the wire. The damage soon spread to four more plots, and more slowly to other plots, all three modes of entering by burrowing, climbing and cutting being used. By July 1934 only three plots remained intact, although three others were only lightly affected.

There was little damage during the rains of 1934, but it was renewed in the following cold weather. By December 1934 only two plots remained intact, and damage in most of the rest was becoming very serious. Soon after the last two were also entered, although the damage was not severe.

The fences were inspected daily and any breaches repaired at once. When the fence round a plot had been breached and repaired about a dozen times, and damage to the *semal* plants had become considerable, the plot was abandoned, the fence having proved useless.

The relative value of the various factors of the fencing in resisting porcupines can be summarised according to the three modes of attack.

Burrowing—

Netting sunk vertically.—Burrowing under the wire was effected in the following cases:

Depth sunk.	Nature of wire netting.		
8″	19 gauge,	2″	mesh.
9″	19 ,,	1½″	,,
10″	20 ,,	1″	,,
12″	19 ,,	1″	,,

The 11″ depth, with netting 18 gauge, 1½″ mesh, was not burrowed beneath, nor were the 13″ and 14″ depths, with 22 gauge, ¾″ mesh and 20 gauge ¾″ mesh, respectively.

Netting "layered" outwards on surface of ground and pegged down.—Burrowing was effected under both 15″ and 18″ layering in the case of one plot each. Probably the other plots with layered

netting would also have been entered by burrowing had not climbing proved an easier method for the porcupines.

Climbing.—All the fences with a vertical height above ground of 15″ and 18″, whatever the gauge and mesh, were very soon climbed over repeatedly. The 22″ and 23″ heights (20 gauge $\frac{3}{4}''$ mesh, and 22 gauge $\frac{3}{4}''$ mesh, respectively) were climbed over a little later, and the 24″ height (19 gauge 1″ mesh) also eventually succumbed to this mode of attack. None of the heights from 25″ to 28″ were climbed over, whatever the gauge or mesh.

Cutting.—The following were cut through :

19 gauge, 2″ mesh and $1\frac{1}{2}''$ mesh.

20 ,, 1″ mesh.

The following were not cut through, although in some cases this might have been because an easier mode of entry presented itself :

18 gauge,	$1\frac{1}{2}''$	mesh
19 ,,	1″	,,
20 ,,	$\frac{3}{4}''$	,,
22 ,,	$\frac{3}{4}''$	,,

Conclusions.—Although ultimately all the plots were entered, and although also the experiment was not extensive enough for a proper investigation of all the variants involved, the results justify certain general conclusions.

Layering on the surface of the ground, even for 18″ outwards from the fence, is not sufficient protection against burrowing. But with vertical sinking of the netting, burrowing did not get beneath anything more than 1′ deep.

The porcupines ultimately climbed over everything up to 2′ height above ground, but nothing above that height.

Cutting depends on both gauge and mesh ; with a small mesh even the finer gauges resisted cutting, whereas with a wide mesh even the coarser gauges were cut.

It must be emphasised, however, that the various factors are interdependent. Height is not the only factor that affects climbing. A small mesh or a thick gauge makes the wire netting stiffer and therefore less easy to climb over than netting with a wide mesh or of

a thin gauge, which can be more easily bent and pulled down by the weight of the animal.

Possibly, also, burrowing is affected by the strength of the wire. In the experiment, the stronger netting was sunk deeper on the assumption that the porcupines might burrow deeper when they came to an obstacle they could not bend and push upwards. But possibly they were discouraged from further burrowing when they reached the strong obstacle and did not attempt to burrow deeper. Porcupines have sometimes burrowed considerably more than 1′ to enter a forest nursery.

Cutting may also be dependent on other conditions. In the experiment it is probable that more cases of cutting would have occurred if climbing and burrowing had not been so easy in some of the plots. Cutting is probably only resorted to after both burrowing and climbing have first been tried.

Recommendations.—To be effective, a somewhat better type of fencing is needed than was used for any of the plots in the experiment, especially as on a large scale it would not be possible to give the fence the same attention as is possible for a small-scale experiment. To allow a sufficient safety margin, it is suggested that the netting should be sunk $1\frac{1}{2}'$ in the ground and be $2\frac{1}{2}'$ high above ground, *i.e.*, the width should be 4′ instead of the 3′ used for the experiment. With this height the netting must be sufficiently strong to prevent sagging and to resist climbing as well as cutting. 18 gauge and 1″ mesh appears to be the most suitable.

The following specification is, therefore, recommended :

Wire netting, 18 gauge, 1″ mesh, 4′ wide, fixed vertically, with $1\frac{1}{2}'$ below ground and $2\frac{1}{2}'$ above ground, well staked or otherwise supported, *e.g.*, by tying to deer-proof fencing.

This has been tried round a 5-acre *khair* (*Acacia catechu*) plantation at Lalkua in Tarai and Bhabar experiment 8, and is illustrated in the accompanying photo. Plantations in 1932 and 1933 had been very badly damaged by porcupines pulling up the *khair* cuttings soon after they had been put in. In 1934, porcupine fencing of the type

DEER-PROOF AND PORCUPINE-PROOF FENCING

THE PORCUPINE-PROOF FENCING CONSISTS OF RABBIT WIRE 18 GAUGE, 1″ MESH, 4′ WIDE, WITH $1\frac{1}{2}$′ BURIED IN THE GROUND.

LALKUA (EXPT. 8, T. & B. ESTATES).

PHOTO.—E. C. MOBBS.
June, 1935.

recommended was erected with deer-proof fencing round a new plot, and it has proved completely proof against porcupine attack.

This porcupine netting costs about Rs. 6 per running 100′ chain at site with another 12 as. to Re. 1 for sinking and fastening to the deer-proof fence, or, say, a total of Rs. 17 to 18 per running chain for the whole fence. In large plantations, however, where complete protection from porcupines is not essential, 20 gauge 1″ mesh netting only 3′ high, sunk 1′ below the ground has proved sufficient and reduces the cost to between Rs. 14 and 16 per running chain.

OBSERVATIONS ON THE SILVICULTURAL CHARACTERS OF DIPTEROCARPUS INDICUS IN THE AGUMBE FOREST ZONE IN MYSORE STATE

(*Vernacular name—Kanarase—" Challanne, Dhuma*")

BY KADAMBI KRISHNASWAMY, M.SC., D.SC., BANGALORE.

Distribution.—The tree abounds in the Southern Ghats of North Canara (Talbot) and along the Western Ghats from North Canara to Travancore, in evergreen forests up to 3,000 ft. (Troup and Brandis). It occurs abundantly along the ghat head line in the Agumbe forest zone (height 2,100 ft.) and is strictly confined to the typically evergreen areas. The climate in this region is humid. The absolute maximum shade temperature varies from 95° to 100° F., and the absolute minimum from 55° to 65° F. The rainfall varies from 100″ to 300″ or more (Agumbe—350″).

General Description.—Dhuma is a lofty evergreen resinous tree attaining a height of 130 ft. or more and a girth of 14 ft. or over. It has a long, clean, straight, cylindrical bole and an elevated round-headed crown, which wins the first place among the forest trees in the upward race for light in evergreen areas, by standing well above the rest of the forest canopy. The bark is usually light-grey and smooth.

The wood is reddish (rosy) brown to reddish grey, fairly rough, and seasons badly. Owing to the presence of oleo-resinous ducts in the wood, it develops large cracks during seasoning, because the volatile oil evaporates rapidly.

The tree sprouts in the forest areas round about Agumbe during December and January, when one sees the soil under the trees strewn with the reddish tomentose envelopes that cover the leaf buds and are shed during sprouting. The flowers appear during February and March.

Description of Flower.—The flowers are fragrant, white, tinged with red, about 3″ in diameter, in axillary, three to eight flowered racemes. *Calyx:* tube obconic, hoary, puberulous, the mouth contracted in fruit; the two enlarged lobes (wings) 5″ by 1″, oblong, obtuse, strongly 3 to 5 nerved and reticulately veined, the other lobes deltoid. *Petals:* white, tinged with red, linear, obtuse, puberulous without, twisted in bud. *Stamens:* numerous; filaments yellow, linear subulate, terminated by a long slender bristle. *Fruit:* 1″ in diameter, subglobose, pubescent, mouth contracted, unenlarged lobes deltoid ovate.

Fruit.—The fruit ripens from May to June and is large, fairly heavy, with two wings, each about 5″ long.

Germination.—The seeds germinate easily. The cotyledons are hypogeal, fleshy and remain within the fruit. The radicle appears from between the wings and curves rapidly downwards. The petioles of the cotyledons develop in the meanwhile and the plumule emerges from in between them. The tap-root is thick, woody, long and tapering, with few short fibrous lateral roots. The petiole of the cotyledons is 1″ to 1½″ in length. The lamina is about an inch long, obovate and fleshy. The two cotyledons form within the fruit a fleshy mass. The stem is erect and woody. The younger parts are tomentose with stellate hairs. The first internode between the cotyledons and the first foliage leaves is 5″ to 7″ long; the subsequent ones are half to one inch. The leaves are simple; the first pair is opposite, but the subsequent ones are alternate. The stipules are about half inch long and caducous. The young seedling is sensitive

to drought, demands shade and thrives under the evergreen canopy of the forest in spite of the great competition for space.

Silvicultural Characters.—The tree is typically evergreen and grows on a damp rich soil in moist areas. The most robust growth is observable along the ghat head line, but unlike *balgi* and *nagasampige*, which are its associate, *dhuma* prefers even here comparatively even localities, where it can spread its root system to its best advantage. It occurs mostly sporadically, though groups of half a dozen trees or more, in proximity to one another, are quite commonly met with. Even here the space in between these trees are usually occupied by other species. It has not so far been found to be gregarious in the typical sense of this term, though it shows a strong tendency to come up in groups when it has such an opportunity. The admixture of other species is most probably due to the keen competition for space and light among trees existing in evergreen areas.

The presence of *dhuma* in the dense, typically evergreen forest areas shows that, especially during the younger stages, the species is of a shade-bearing nature. The bark is comparatively thin and smooth and hence ill-adapted to withstand damage by fire. If the damage exceeds slight superficial scorching, the young trees are killed outright. The power of coppicing is very poor.

The kind of soil available for *dhuma* in the Agumbe area is the weathered product arising out of granite and gneiss, over which appear hornblendic flows and magnatite quartz schists. Laterite occurs in considerable quantities and is probably a product of the ferruginous schist beds of the area. The uppermost layer-soil actually bearing the tree growth is very rich in vegetable mould, is teeming with decomposing bacteria and ventilated by a host of earthworms which burrow constantly into the soil.

As already stated, *dhuma* trees are capable of attaining a height which makes them the victors in the upward race for light, a feature very characteristic of the vegetation in an evergreen forest. When the forest canopy is viewed from an opposite elevated point, *dhuma* is conspicuously distinguishable in the tapestry of the canopy of the evergreen forest, by its tall stems and round-headed crowns standing

proudly above the rest of the vegetation. The tree becomes all the more conspicuous as one approaches the ghat head line, where *dhuma* is by far the tallest of trees. Sometimes, where the forest displays a quick transition to a slightly more deciduous type, or along the banks of water courses, species of *Calophyllum* and *Eugenia* might appear to dispute the place of *dhuma* among the tallest trees, but such cases are quite seldom. There is usually no pronounced shedding season for the tree although prior to the appearance of the young leaves in December and January, the shedding of the older ones is conspicuously perceptible.

Uses.—The timber is used in South India for building purposes. It is of an inferior nature. It ranks, when untreated, among the second, or even the third, class of timbers. The transition from the reddish grey heartwood to the greyish white living sapwood in the standing tree is gradual. The heartwood is fairly hard and not very durable. It is usually almost devoid of the ducts containing oleo-resinous matter, which occur abundantly in the sapwood. The wood seasons badly owing to the large splits that are developed during the seasoning. The tendency for splitting is most pronounced in young trees containing immature wood. Green wood weighs from 65 to 70 pounds per c.ft., while air-seasoned wood weighs from 44 to 47 pounds. Its strength is, according to Troup (" Indian Woods and Their Uses," p. 131), P=695 (Bourdillon).

The Abundance of Dhuma in the Agumbe and Balehalli State Forests.—The bulk of the forest crop of trees in the Agumbe forest zone consists of *balgi* (*Poeciloneuron indicum*), *dhuma*, *nagasampige* (*Mesua ferrea*) and *surahonne* (*Calophyllum elatum*), while ebony, white cedar, *Artocarpus hirsuta* and *toon* form only a small portion of the crop, namely 2·3 per cent. There are, in addition, a host of accessory and auxiliary species, which, along with the multitude of herbs and shrubs, occupy and form at present one complete patch of green from near the ground level to the tops of trees. *Dhuma* generally confines itself to a thin belt of vegetation about four to six furlongs in breadth along the head of the ghats. Here and there, however, a tongue of *dhuma* trees may project from the ghat head

line up to two miles in the interior, in company with *poon* (*Calophyllum tomentosum*), *balgi* and *nagasampige*. Unlike *balgi*, the distribution of *dhuma* is not uniform throughout the forest. It is very abundant in compartments 3, 5 and 11 of the Agumbe and 7 of the Balehalli forest, and moderately so in compartments 6, 7, 10 and 12 of the Agumbe forest. In the Agumbe forest zone, the abundance of the species diminishes rapidly with the fall of the altitude. The gigantic *dhuma* tree, which strikes the eyes of the first observer, is comparatively rare when one reaches half-way down the ghats, while at its foot the tree has shrunk almost wholly into the background and is to be carefully sought for among the vegetation. *Lagerstroemia lanceolata* (the benteak), the *Terminalias* and species of *Hopea* now dominate the vegetation, which here has diminished not only in height, but also in luxuriance.

The most suitable growth conditions (the optimum factors for the growth of this species) are present just at the head of the ghats, where one sees the largest specimens of this kind. The luxuriance of growth diminishes rapidly as one proceeds inwards from the ghat head line. For purposes of utilisation trees standing in comparatively flat localities with less depth of soil are preferable to those standing in the richer and deeper soil on the steep slopes of the hillocks present at the head of the ghats. It has been found in general that the more rapidly the tree has grown and the more favourable the conditions for its growth, the less uniform is the substance of the wood owing to the greater abundance of the ducts containing oleo-resinous matter in the wood. In the gigantic trees standing right at the head of the ghats the loss of timber during conversion owing to the occurrence of splits is, therefore, comparatively greater than in the case of those trees standing in more even localities, away from the ghat head line. The tendency of the wood to develop splits during seasoning is greater in the gigantic trees referred to, because the volatile oil evaporates more readily from the wood tissues during seasoning than the water, thereby causing greater inequality in the internal tension of the woody tissues.

When the exploiting forestman perambulates the *dhuma* areas in the Agumbe and Balehalli forests during his selection of trees for

felling, he cannot fail to notice a fact of far-reaching importance connected with the growth of these trees, namely, *the poverty of the forest in the intermediate girth (diameter) classes.* The majority of the trees of *dhuma* met with by the marking officer have reached the stage of exploitability. There is then a paucity of the abundance of the smaller girth classes, which is followed by a fair abundance of young growth that has yet to reach the pole stage. A glance at the results of the valuation survey of the forest tends to confirm the above :—

Record of the Valuation Surveys, Agumbe State Forest.

Diameter classes :			Over 36″	30″ to 36″	24″ to 30″	18″ to 24″	12″ to 18″	6″ to 12″
Compartment	I	..	28	10	16	12	7	8
Do.	II	..	17	10	4	17	3	5
Do.	III	..	53	13	19	26	53	137
Do.	IV	..	23	6	9	5	11	19
Do.	V	..	54	32	32	43	18	61
Do.	VI	..	43	43	25	35	29	24
Do.	VII	..	36	14	27	33	24	15
Do.	VIII	..	27	1	16	23	9	18
Do.	IX	..	6	1	2	18	9	4
Do.	X	..	43	40	17	29	58	32
Do.	XI	..	89	5	45	29	36	15
Do.	XII	..	40	99	69	72	36	50
Do.	XIII	..	27	13	16	45	34	34
Do.	XIV	..	4	1	2	5	3	4
Do.	XV	..	..	..	..	..	1	1
Do.	XVI	..	2	1	..	5	7	15
Do.	XVII	..	23	62	54	19	21	28
Do.	XVIII	..	4	9	7	14	11	9
Do.	XIX	..	3	27	47	35	12	19
Do.	XX	..	..	6	3	6	9	6
	Total	..	512	395	410	471	391	504

Record of the Valuation Surveys, Balehalli State Forest.

Diameter classes:		Over 36″	30″ to 36″	24″ to 30″	18″ to 24″	12″ to 18″	6″ to 12″
Compartment	I ..	28	10	16	12	7	8
Do.	II ..	17	10	4	17	3	5
Do.	III ..	14	19	5	30	24	31
Do.	IV ..	3	3	3	6	8	12
Do.	V ..	11	4	3	4	16	17
Do.	VI ..	27	23	27	35	25	53
Do.	VII ..	64	40	29	33	36	57
Total	..	164	109	87	137	119	183

With the exception of compartments 6, 12, 17 and 19 of the Agumbe and 3 of the Balehalli forests, trees which have already reached the exploitable diameter number the largest in all the other compartments. Next in number to the diameter class of mature trees stand those of the smallest diameter class. This means in other words that there is a large stock of mature trees in the Agumbe and Balehalli forests. The following figures giving the estimate of growing stock in number of trees makes this point clearer :

Diameter classes :	Over 30″	24″ to 30″	18″ to 24″	12″ to 18″	Under 12″	
Agumbe Forest ..	9,628	4,630	4,877	4,012	4,876	sound
	243	9	80	32	36	unsound
Balehalli Forest ..	2,877	900	1,450	1,222	1,883	sound
	135	11	11	11	..	unsound

This remarkable fact, namely, the abundance of the largest diameter (girth) class in the two state forests in question sets one thinking as to what might be the probable cause for the same. When one perambulates the *dhuma* areas, he cannot fail to notice the abundance of the natural regeneration of this species. Seedlings of heights varying from a foot to ten feet or more are quite common. Those

which have reached the pole stage are, however, comparatively rare. From the pole stage onwards, *dhuma* dwindles in the composition of the mixed forest crop and again bursts forth into prominence only in the top-most story of the vegetation, with its enormous stems standing well above the rest of the forest crop in height and attaining girths commonly reaching 14 feet or more.

The reason for the paucity of dhuma from its pole stage onwards to its exploitable stage is not far to seek. A closer study of the nature of this species in relation to the œcological factors prevailing in the evergreen forests reveals the real cause which, in the writer's opinion, is as follows:

Dhuma is a moderately strong shade-bearer in its seedling and sapling stages, as is evident from its broad, flexible, delicate leaves, which have a poorly developed cuticular layer and abundant spongy mesophyll. The seedling can, therefore, thrive well in the dense shade of the evergreen forest, where quite often hardly a ray of sunlight reaches the soil. This accounts for the comparative abundance of the natural seedlings of this species in the forest. On advancing from the stage of the sapling to the pole stage, the seedlings of *dhuma*, which have comparatively broad leaves and flat crowns, are unable to force their way upwards through the dense overhead canopy and keep pace in the upward race for light along with species like *balgi*, *nagasampige* and *kiralbhogi*, which possess linear or lanceolate tough leaves and dome-shaped crowns. The *dhuma* seedlings perish, therefore, in large numbers. When, however, a comparatively open area is found in the forest, where the more hardy *balgi* and *nagasampige* do not compete with *dhuma* side by side for light, such as what one finds where groups of *dhuma* seedlings have come up almost exclusively by themselves, the boles of the seedlings shoot up almost perfectly straight and cylindrical to a height of a hundred feet or more and once at the top the tree spreads its crown laterally until it assumes the shape of an umbrella. The shade-bearing thin cuticled leaves so characteristic of the *dhuma* seedlings are now replaced by the tougher, thick cuticled, leathery, dark-green leaves, which demand light, and are comparatively drought resistant.

An interesting fact observable in our forests is the abundance of natural regeneration of *balgi* and *nagasampige* even in areas where the top layer of the leaf canopy is dominated by *dhuma*. In such cases one would naturally expect to find a good number of seedlings of *dhuma* under the mother trees. This is, however, not always the case. The large cotyledons and the long tap root of the *balgi* seedlings probably help them to establish themselves more successfully than the seedlings of *dhuma*. The adverse effect of a thick layer of leaves on the soil is probably one of the causes of the paucity of *dhuma* seedlings as compared to those of *balgi*.

On examining the cross-section of a leaf of an adult tree of *dhuma* with the aid of a powerful lens, or under the low power of a microscope, one sees that the leaf of a mature tree, in contrast to that of a young seedling, possesses a comparatively thicker cuticle, a closely packed palisade tissue with multiple rows, deep set stomata and meagrely developed intercellular cavities. This is also what one would naturally expect after a closer comparative study of the microclima of the interior of the forest, with that at the region of the level of the tree crowns. Whereas in the forest interior prevails an atmosphere with its humidity approaching the saturation point, there reign above the level of the tree-crowns strongly xerophytic conditions during the major part of the day, because during most parts of the year the scorching tropical sun pours its fierce rays on the horizontally spread crowns of the forest trees.

To sum up, it can be stated that the relatively flat crowns and the comparatively mesophytic nature of the broad leaves of young *dhuma* seedlings, incapacitate them from making their way through the dense leaf canopy of the evergreen forest to the top layers. This is one of the principal causes for the rarity of the middle age classes of these trees in the Agumbe forest zone. Once the tree has made its way through the leaf canopy and reached its top layers, it spreads its crown far above those of its competitors and is now the stronger. Further, the competition for space with the hardier species like *balgi*, *kiralbhogi* and *nagasampige* shuts off *dhuma* from the major portions of the forest areas and allows it to come up only at such

spots where the factors for its growth and existence are most favourable. This is one of the reasons why *dhuma* comes up at such favourable spots in groups of almost even-aged trees.

At present the forest operations at Agumbe aim at the removal of only such of the trees as have reached their exploitable girths and these are by far the most abundant in number as detailed above. Owing to the lateral expansion of the crowns of the mature trees and their occurrence, often in close proximity to one another, the breaks caused in the evergreen leaf canopy by felling such trees are much larger and more conspicuous than those caused by felling *balgi* or *nagasampige* trees. Such blanks afford, in the years following the fellings, opportune areas for the herbaceous vegetation to settle and compete for space. Among one of the most conspicuous of such herbaceous species is to be mentioned the wild cardemom, whose seeds spread rapidly through natural agencies and germinate in large numbers.

Among other trees occurring abundantly in the *dhuma* areas, but so far left unmentioned owing to their inferiority of position from the forest utilisation point of view, are *hadasale* (*Dichopsis elliptica*), *gulle* (*Mastixia arborea*) and *holegara* (*Holigarna arnottiana*). All these are softwoods. Although in abundance, they rank only next to *dhuma*, *balgi* and *nagasampige*; they play an important part in making up the vegetation of the *dhuma* areas. They compete with *dhuma* in height, but are most often unsuccessful. Being comparatively broad-crowned even from their younger stages, they impede the height growth of *dhuma* in its younger stages much less than *balgi* or *nagasampige*, and are not, therefore, such powerful rivals during growth as these.

The demand for the less durable woods in general, and *dhuma* in particular, has of late been increasing rapidly. Owing to the ever-increasing scarcity of the more durable woods as a result of the extensive exploitation of the virgin forests in almost every tropical and sub-tropical country in the world, the future generations will have to depend more and more upon the less durable woods rendered resistant through wood preservatives. The modern wood-preserving

methods promise a great future for *dhuma* timber, which even otherwise is quite long-lasting when not in contact with the soil. The natural regeneration of *dhuma*, though fairly abundant, suffers owing to its association in these forests with the more tenacious species like *balgi* (*Poeciloneuron indicum*), *kiralbhogi* (*Hopea parviflora*), and *nagasampige* (*Mesua ferrea*) as detailed above, because the latter, along with their associates, subdue the natural seedlings of *dhuma* from reaching their pole and adult stages in large numbers. It seems, therefore, not merely profitable, but even quite essential to supplement the natural regeneration of this species by some mode of artificial regeneration.

The cheapest and perhaps one of the most effective methods would be to sow *dhuma* seeds in lines 8 to 10 feet apart from one another, after clearing the ground along the lines of the debris so as to expose the mineral soil. The last seems by experience to be very essential, because the ground is very often covered in the interior of the forest by a thick layer of dead leaves, which impede the establishment of the germinated seed by shutting off the mineral soil from it. After three to five years, when the young seedlings start putting on height rapidly, the large shade trees should be girdled, so as to allow sufficient sunlight for the seedlings from above. The natural seedlings of *balgi*, *nagasampige*, *kanasoka* (*Humpboldtia brunonis*), *kadubende* (*Polyalthia cerasoides*), etc., which come up in between, as also the annuals like *Leea aspera*, wild cardemom, wild turmeric, *Colebrookia oppositifolia*, *Callicarpa lanata* and *Macaranga peltata* should be removed annually, because the broad-leaved *dhuma* can stand much lesser congestion than *kiralbhogi*, *balgi* or *nagasampige*. Care should, however, be taken to see that there is sufficient shade when the seedlings are young.

LITERATURE

Hooker, Sir Joseph Dalton—Flora of British India, Vol. I.
Cooke, Theodor—Flora of Bombay, Vol. I.
Gamble—Flora of Madras Presidency, Vol. I.
Troup—Silviculture of Indian Trees, Vol. I.

Warming und Græbner—Lehrbuch der Okologischen Pflanzengeographie, vierte Lieferung, 1932.

Schimper, A. F. W.—Pflanzengeographie auf oekologischer Grundlage.

Lundegarth—Klima und Boden.

Braun-Blanquet—Pflanzensoziologie.

Kadambi, Krishnaswamy—Observations on the Growth of Kiralbhogi, *Mysore Forest Journal*, 1929.

Do. .. A short note on the evergreen belt, Shanker State Forest, *Mysore Forest Journal*, 1929.

Do. .. The Evergreen Forest, Agumbe Zone, *Mysore Forest Journal*, 1934.

Do. .. Immergrüne Wald in Dekkan, im süd-western Indiends, Forstwissenschaftliches Zentralblatt, 1932, München, Germany.

IRRIGATION RESEARCH

Imperial Bureau of Soil Science. Monthly Letter No. 43, May 1935.

The classical experiments of Veihmeyer and Hendrickson, which have changed the outlook on irrigation sciences, cannot be too widely known. An admirable summary of their work and results has recently appeared in the *Farmers' Weekly** (South Africa), a journal which succeeds to a remarkable degree in presenting scientific matter in a form which the farmer can appreciate. The article is rather too long to be reproduced in full here, but the following extracts contain the points of greatest interest to the soil scientist.

"Since earliest times, three things have been assumed about water and the soil. (1) *That plants and trees used moisture as fast* as they could get it and flourished accordingly. (2) That water diffused itself through the sub-soil, as through a lump of sugar. (3) That uncultivated land exposed to the sun would dry out. By

* "Saving on the Irrigation Bill." By H. E. Pels, Vol. 48, No. 1,338 (1524-1525).

whirling, perforated pans, scientific see-saws, waxed-paper partitioned and cross-section trenches, Veihmeyer and Hendrickson proved that all of these ideas were wrong. They cut irrigation furrows through a plot of dry ground, and ran measured amounts of water through them. Then they dug a six-foot trench across the line of furrows and examined its sides for results.

"Under one furrow in which they had run three inches of water they watched the dampness descend through the soil to the depth of a foot, and then suddenly stop. Where the dry part began, it began abruptly, immediately adjacent to the thoroughly wet portion. They found that every portion of the wet area was equally wet, and the water content in each was approximately 25 per cent. of the oven-dry weight of the soil.

"Again they ran three inches of water in the furrow, and now they watched a curious thing happen. The top foot, through which this had to percolate, was not a whit wetter after the percolating had finished than it had been before. But the second foot became exactly as wet as the first, and just as uniformly so. Then abruptly where the third foot began, the soil was as dry as though never watered.

"By carefully measured irrigations they were able to wet each foot, or half-foot, to exactly this 25 per cent. ratio of wetness, clear to the bottom of the trench. But no amount of water would make any portion any wetter than this; and no layer, no matter how far down, be found to contain any lower percentage of water.

"There is a fixed amount of moisture, they discovered, that any given type of soil will hold so firmly as to resist the force of gravitation. Until a layer of particles has received this full quota of water, it will let no moisture pass through it, but will seize and hold it avidly. When the capacity of all those particles is reached, additional water flows down to the next layer, and then to the next, bringing each to its full capacity before proceeding lower.

"So, as far down as the water goes the soil must be wet to a uniform degree, represented by the soil's holding capacity or field capacity, as the investigators term it. No soil recently surface-irrigated, consequently, can be half-wet, or three-quarters wet.

"Microscopic examination revealed that the water is not held inside the particles, but between them, being supported in tiny wedges at the points where the particles come together. Clays and loams hold more water than sands, but however the field capacity may vary for different soils, for any given type of soil it is always constant.

"Farmers and scientists alike have always taken it for granted that trees used up the available water in the soil as fast as the roots would permit, but a very ingenuous experiment with fruit trees showed that, other things being equal, the amount of water consumed by a tree depended mainly on its leaf area. Variations in the rate at which moisture was extracted from the soil were produced by weather conditions, which promoted or retarded evaporation from the leaves.

"In determining the exact 'wilting point' at which the tree began to die from insufficient water, it was found that even after the leaves had begun to wilt nearly a third of the original water-supply still remained in the soil. Further examination revealed the soil to be actually moist.

"Just as a certain amount of moisture, up to field capacity, is held so tightly as to resist the pull of gravity, so a part of this is held, even more tightly, and resists even the capillary pull of the roots.

"This permanent wilting percentage, as it was called, bears a fixed ratio in any soil to the soil's field or holding capacity. But it varies widely in different types of soil, ranging from 25 per cent. of the field capacity in one case to 70 per cent. in another, depending on the composition of the soil. Some clays, for example, have a high field capacity, also a high wilting percentage, owing to the tightness with which their closely-packed particles cling to the moisture. Some sands, on the other hand, owing to the looseness of their composition, not only hold less water than the clays, but give it up more readily to the roots.

"The amount of moisture in a given soil in excess of the permanent wilting percentage is most important. As the residue remains in the ground indefinitely and never has to be replaced, knowledge of the wilting percentage and the field capacity of a soil enables the

irrigation farmer to determine scientifically just how much water he must supply. Another discovery shows how to supply this water most effectively. The belief has been almost universal that water placed anywhere near the roots will find its way to them by capillary attraction. But tests showed that this is by no means true.

"The lateral movement of the water was not nearly so great as had been presumed, and was due solely to gravity. A quantity of water that will wet the soil to a depth of 6 feet will spread laterally only 2½ feet from the centre of each furrow, and spacing the furrows so that the lateral movement of the water just closes the gap between, without any overlapping, is an important phase of successful irrigation farming.

"By withholding water many farmers believed that they could force a tree to send its roots down to new low levels in its search for subterranean water. The work of the investigators showed that, so far as the movement of the roots is concerned, this theory is correct. Roots will go down as far as 30 feet in the ground after water. But getting that water up into the tree is another matter.

"By means of auto-irrigators—porous containers connected by pipe lines with the surface—the men were able to irrigate the seventh-foot level, while permitting the upper six feet to go dry. Although they poured enough water down to support a number of trees the experimental one wilted. The roots were unable to raise the water fast enough from that depth to keep pace with the tree's needs. The average tree in an orchard sends its roots down five or six feet. The bulk of them, however, are bunched in the second, third and fourth feet.

"The time-old theory was that there was a considerable capillary movement of the water through soil, and that as fast as water evaporated from its surface new moisture rose from below to take its place until the entire sub-soil had dried out. To break up these capillary routes, and put a moisture-proof cover on the ground, farmers are still spending vast sums of money in discing, cultivating and mulching their orchards.

"Having already discovered that the capillary action was much less than had been supposed, the investigators then tested this belief.

They found that a tank of unplanted soil, watered to soil capacity, would lose moisture by evaporation immediately after irrigation, less rapidly for about a week, and then at a rate so slow as to be barely perceptible. At the end of 80 days the soil had lost only twice as much moisture as in the first week; and when the soil itself was examined it was found that it had lost no moisture from below the eighth-inch level, and of these eight inches it was only the upper four that were completely dry. The fact that the top eight inches will eventually dry out is of no consequence to the orchardist, since his roots are all below that level. So that except for shallow-rooted plants the money spent on cultivation, as far as it is designed to prevent evaporation, is all thrown away.

"Weeds and cover crops, moreover, were found to be accomplishing just the reverse of their intended purpose. For they themselves were busily extracting from the soil the moisture that could have been used by the trees. One astonishing demonstration showed that four young morning glories use as much moisture in a given time as a tree, and as much in four or five days as would have been lost through evaporation in as many years.

"After the experiments had been completed the discoveries were applied to vineyards and orchards, orange groves and cotton plantations in nineteen counties in California. Immediately it was discovered that many farmers had been using twice and three times as much water as was necessary. But the waste didn't end there. In some cases it was found that the excess water was actually cutting down the size of the crop, and besides costing the farmer from one to seven pounds per acre annually, the excess water was robbing him of almost a third of his potential crop. The reason for this reduction was that the excess water fills the pore-space in the soil, displacing the oxygen that the roots require.

"Several years have passed since the first field application of these discoveries. Thus, sufficient time has elapsed to show the immense practical value of the researches.

"In Mendocino County, to take a typical example from the official hand-book of the Bureau of Agriculture, Washington, the

combined irrigation and cultivation costs used to run to the neighbourhood of £7 10*s*. per acre ; now, under the new scheme, it has been cut to as low as £1 5*s*. per acre. The total saving in the nineteen counties that have put into practice the findings of Veihmeyer and Hendrickson was computed by the Bureau at in the vicinity of a million and half pounds annually, and these figures are expected to increase proportionately as all the irrigation farmers in California adopt the same methods."—SILVA.

REVIEWS

EROSION CONTROL ON MOUNTAIN ROADS

BY C. J. KRAEBEL

(U. S. DEPT. AGRI. CIR. NO. 380, MARCH 1936, PRICE 10 CENTS, FROM SUPERINTENDENT OF DOCUMENTS, WASHINGTON, U. S. A.)

Both from the forester's and the engineer's point of view this book is invaluable, and its excellent illustrations show at a glance what serious havoc ill-considered road alinement may bring upon the surrounding country by upsetting the natural drainage and exposing long slopes of made earth to erosion on banks and cuttings.

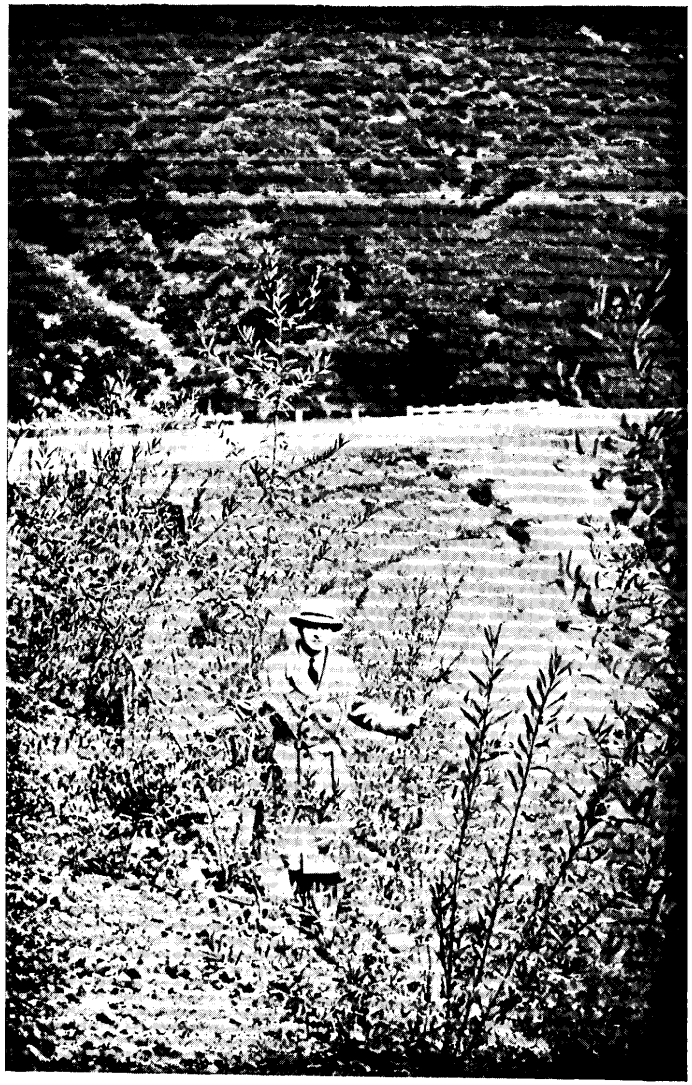
The author is a forester of wide experience in the U. S. A. and the tropics, but his work on this question of road erosion in California has so impressed the road engineers that he is now regarded as their authority on the planning of road drainage on proposed alinements, as well as the afforestation and reclothing of slopes for those already built. In California the question is of particular interest and importance owing to the large development of "scenic highways" to open up that beautiful country for the ubiquitous motorist and holiday-maker. A good deal of this work, therefore, consists in a sort of landscape gardening where, as so often has happened, the

engineers' alinement has scarred the face of forest-clad hills with unsightly screes. In India the urge to beautify landscapes which the engineer has spoiled may not be a legitimate charge on provincial funds, but many of our hill roads are not only unsightly but dangerous with increasing erosion, so the remainder of Kraebel's trenchant criticism of road-builders' methods holds good. Once the subject has been studied and the acceleration of erosion caused by road making is appreciated, the reader will constantly be meeting fresh instances wherever he goes in India.

A point that has appealed greatly to some engineers to whom I have shown this little book is the use of cribbing of interlocking metal or precast concrete bars to support the outer third of any road bench cut along a hillside. This not only reduces the total excavation, but the crib holds all or nearly all of the excavated material, thus making a more stable slope both above and below and avoiding the usual unsightly scars of jettisoned material. The same thing could be done on forest roads by using logs or scantling of any durable or treated wood for the crib work.

A point which should appeal to foresters is Kraebel's method of "contour wattling" for revetting slopes which are being planted. In this, "wattling" does not signify upright hurdles, but the packing of lengths of bound brushwood or grass into thick cables partially buried along a slope at regular contour intervals. These cables are staked down with long stump cuttings or branches of any hardy species of bush or tree which will take root, or failing this, with ordinary wooden stakes driven in. Between these cables the ground is sown with any quick-growing cheap herbaceous seed such as barley, grass, mustard, or local cereal crop or weed, which will produce a quick cover and root mat to protect and anchor the loose soil while the more permanent vegetation of planted bushes or trees is taking hold.

An example of Kraebel's contour wattling results showing one season's growth of *Baccharis viminea*, and the author himself in the picture, is reproduced in Plate 49. This and the other photo of erosion from road culverts were taken during a recent tour in



ROAD SLOPE REVETTED BY "CONTOUR WATTLING," SHOWING ONE SEASON'S GROWTH OF BRANCH CUTTINGS OF *Baccharis*, A COMPOSITE BUSH. SAN GABRIEL HIGHWAY, S. CALIFORNIA

EROSION DAMAGE CAUSED BY CULVERTS ON A HILLSIDE. THE BETTER PLANNING OF ROAD DRAINAGE WOULD AVOID OR REDUCE SUCH DESTRUCTION

Photos: R. M. Gorrie.

California, where Kraebel proved an invaluable guide and a delightful host.

The objects of the contour wattling on steep slopes are to stabilise the loose upper layer of soil against downhill movement or disturbance by trampling, to stop the formation of small channels and incipient gullies in the uncompacted slope, and to give the vegetation a chance of catching hold. The drier and more trying the climate, the more such revetting is necessary on steep slopes. The details of the method are given in the pamphlet. It is being tried by Punjab Silva staff on the railway bridge embankment of the Jhelum River bridge; this has just been raised several feet and the railway authorities have asked for help in getting some plant cover established on the steep sandy banks. The contour wattle cable is of *kana* grass (*Saccharum munja*), the pegs of *Ipomoea carnea*, the catch-crop is a *Phaseolus*, locally used as a rains crop, and the permanent covering is of *Agave* suckers dug up from hedge rows.

R. M. G.

THE FAUNA OF BRITISH INDIA : COLEOPTERA (GALERUCINAE).

BY S. MAULIK. (TAYLOR AND FRANCIS, LONDON.)

This is Mr. Maulik's third and final volume in this series and completes the family Chrysomelidae. The value of this stout volume of 648 pages will be best appreciated by those who have attempted to identify an Indian Galerucine beetle with only the original descriptions, usually incomplete, and scattered among a great number of scientific periodicals, to help them. We have now a complete and reasoned collation of all the information on the subject and the Indian student will now be able either to name his specimens, or to decide if a new species is concerned, with as much accuracy as is possible without comparison with the type specimens. It is easy to understand Mr. Maulik's almost audible sigh of relief (Preface) on completing this book, which, apart from other considerations, must have been a severe tax on the author's patience : we are told that,

in order to arrive at definite conclusions, he examined nearly 600 examples of one species alone (p. 161).

In the Introduction the structural characters of the beetles are fully explained and a summary of what is known of biology and early stages is given. The author compares the value of adult and larval morphology for arriving at a phylogenetic arrangement and discusses certain conclusions arrived at by A. G. Boving, the well-known authority on coleopterous larvae.

There are numerous lucid text-figures, a coloured plate and a map.

J. C. M. G.

" QUEEN MARY "

R. M. S. "QUEEN MARY"—THE SHIP OF BEAUTIFUL WOODS.

BY H. T. W. BOUSFIELD (CUNARD WHITE STAR CO.)

This little brochure of 32 pages is an extremely attractive booklet for anyone interested in woods. It is a description of the woods used in the " Queen Mary " presented in the form of a running commentary and profusely illustrated with coloured plates and excellent photographs. The author describes the interior decoration of the " Queen Mary " in the following words: " Grandeur and yet simplicity, splendour and yet exquisite taste; only one medium could perform this miracle—wood." Such praise for the much maligned product of forests must be very gratifying in the ears of foresters. Fifty-six of the world's rarest and finest woods were used for the decoration of the ship. India's quota comprised silver-grey, laurel, padauk, rosewood, satinwood and teak. Teak apparently does not figure largely in the interior decorative schemes of the ship, but it is the principal wood used for all the exterior fittings and decks, and over 1,000 tons of teak were utilised for this work alone, a striking commentary on the size of the boat. That the " Queen Mary " has done much to re-establish the beautiful woods of the world there is little doubt. The author's concluding words are as follows: " Nobody has built a ship like this before. Nobody before has thought of using the simplicity of nature to create beauty. This is a ship of beautiful woods, and it is more than that. It is a ship of beauty."

H. T.

BUCH DER HOLZNAMEN

PART IV/1, MURGA-SAGE ; PART IV/2, SAGET-ZYPRESSE

BY DR. HANS MEYER

(*Hannover : M. & H. Schaper verlag*, 1935-36)

These two volumes complete the Book of Woodnames, which work was undertaken by Dr. Hans Meyer, under the auspices of the Institute of Applied Botany, Hamburg. Unfortunately Dr. Meyer died before the publication of the last volume, but the work will be continued by the Institute, and it is contemplated that a supplementary volume will be brought out in 2 to 3 years' time to make the list more complete and up to date. In the concluding volume an invitation is issued by Dr. Bredemann, the Director of the Institute, to all those interested in this work to kindly participate in its enlargement.

The first two volumes of this work were reviewed at length in this journal in the April 1935 issue, pages 274—276, and it is, therefore, not necessary to go into details again. The list of woodnames is a very comprehensive one, covering a total of 564 pages, and should form a useful addition to the library of a Wood Technologist.

With regard to names of some important Indian woods, a casual glance through these two volumes shows some inaccuracies, which would require correction in the next edition. Under the heading sal, in addition to *Shorea robusta*, *Schleichera trijuga* and *Terminalia tomentosa* are mentioned, which should be omitted. In many cases, where one name applies to more than one species, it would be a good plan to indicate the species by a bolder type for which the name is more commonly used. Under "Indian oak," *Tectona grandis*, and *Barringtonia acutangula* are given, while no mention is made of various species of *Quercus* found in the country. As equivalent for toon (page 525) and thitkado (page 517) *Toona ciliata* is named, which should be substituted by the present accepted nomenclature for the species, namely *Cedrela toona*. On page 416, "parroria" should read "parrotia" and on page 517, "thitpyn" should be corrected into "thitpyu." A few errors and misprints in a work of this magnitude do not, however, detract from the value of the book.

S. N. K.

EXTRACTS

THE LOST HOSTS OF PASSENGER PIGEONS

WILFRED B. FRIESEN

Bird lovers can never forget the continent-wide slaughter that resulted finally in making the Passenger Pigeon a totally extinct species. Cash rewards amounting to $ 5,000 offered for the discovery of one nesting pair of genuine passenger pigeons have been withdrawn years ago for the simple reason that the quest was finally recognised as futile. The last specimen died in Cincinnati Zoological Gardens in 1914, after living 20 years in captivity. And since then no one has seen a living passenger pigeon though many have claimed the rewards offered. On investigation the results disclosed many mourning doves but no pigeons.

Explanations of this tragic phenomena have been quaint if nothing else. Some suggest that the pigeon may have attempted a transoceanic migration and from exhaustion fell into the sea and perished, or that it has successfully migrated to some unknown land and continues to thrive in its old time unbelievably large numbers, undisturbed and happy. Briefly the passenger pigeon has been ruthlessly exterminated by the insatiable apetites of men.

Alexander Wilson, pioneer ornithologist of U. S. A., writes an account of the arrival of a multitude of pigeons at a breeding place in Kentucky that strikes the writer as being almost incredible. Firstly he attributed the migration of these birds to the search for food, moving as they did to a new breeding place when the food in the vicinity was exhausted. The particular breeding place of which he wrote was about 40 miles long and 3 miles wide, and represented an area of woodland in which the trees were of sturdy growth, and particularly free from underbrush. Here millions upon millions of pigeons nested, weighing the branches of the trees so heavily that these were constantly breaking off and falling to the ground where thousands of creatures were destroyed.

When the squabs had almost reached maturity (and incidentally only one young was hatched to a nest, though often two eggs were laid, people came in wagons, carrying their cooking utensils and paraphernalia necessary to destroy, clean and preserve thousands of birds in preparation for the markets or private meat supplies.

Hundreds of pigs were brought along and fattened on the squabs and eggs that dropped to the ground continually. The axeman fell to finally, and cut down the trees which seemed to hold the most nests. According to reports, some trees had as many as a hundred nests. Wilson describes it all in the most painstaking detail, remarking especially on the climax of the slaughter when the noise of crowding and fluttering birds was so intense that one could scarcely speak to one's neighbour and be heard, and the ground was covered for miles with carcases. No one during the height of the industry, for such it had in truth become, considered that this wholesale and absolutely unbridled slaughter could have but one end—extinction. Later, in the year 1848, the state of Massachusetts gravely passed a law protecting the pigeon-killing industry from foreign interference ! It was generally agreed that there were too many pigeons and that the supply in consequence could never be exhausted.

To give us some conception of the phenomenal extent of these flocks, Wilson tells of a roosting scene which he witnessed on the banks of the Green River in Kentucky. People had gathered in the great forest for hours preparatory to the evening slaughter. Not long after sundown, someone shouted, " Here they come ! " though Wilson says that there was no need to announce their approach. The noise they made, still distant, reminded him of a hard gale at sea passing through the rigging of a close-reefed ship. As the birds arrived he felt a terrific current of air, and the noise became almost deafening. Thousands of pigeons were knocked down by polemen in a few minutes. For hours they continued to arrive, so thickly in fact that they were forced to alight anywhere, and one on top of the other, until solid masses as large as hogsheads were formed on the branches all around.

No one dared to venture within the lines of devastation for fear of being smothered or struck by branches which cracked down continually under their too heavy burdens of birds. All night the pigeons kept coming and the slaughter was extended until morning when the ground everywhere was inundated with bodies.

As has been mentioned, the passenger pigeon's object in migrating was the search for sustenance. Climatic conditions had little or no influence on them, they remaining indifferent to the most extreme weather and breeding as far north as the Hudson Bay. It can be understood to what shameful extent these beautiful creatures were vulnerable to the attacks of men when it is considered that most of the pigeon population of the entire continent was gathered into perhaps a half dozen huge flocks of the kind described. In flight formation they would represent an unbroken-front of several miles and more than one naturalist has remarked on the beautiful evolutions. Flying at the rate of about 60 miles an hour, they sometimes darkened the earth for hours, and created an impression of a hailstorm by their excrement.

Wilson endeavoured to arrive at an assessment of the size of the flock he mentioned in his writing. Judging the flight to be a mile in breadth and the speed to be 60 miles per hour, he allowed for 3 birds to the square yard, and concluded that there were something over two billion pigeons in that particular body !

Though the chief food of the passenger pigeon was beech mast, it would feed upon all manner of grain and fruit and favoured chestnuts above most foods.

Wilson estimated that each bird consumed a pint a day, and that the number of birds mentioned would thus require 17,000,000 bushels of food a day. A flock such as this might easily make away with the entire Canadian wheat surplus in something less than a fortnight !

The killing of passenger pigeons seems to have approached something very near to a major industry in the United States at a certain period. For 40 days, three carloads of pigeons left Hartford, Michigan, daily for the markets, a matter of approximately 12,000,000 birds in a little better than a month. Many other centres representing a wide-flung area did a similar commerce, creating at times such a glut in the market that dressed birds sold as low as 1 cent apiece. Men contrived nets and individually averaged 20,000 birds in a short season. With sublime optimism and a blind faith in the propagating abilities of dead birds, people continued the slaughter until suddenly there was a definite decrease in their numbers. Several states passed laws to protect the birds, but these first manifestations of sanity appeared too late.

The passenger pigeon whose habitat had extended from the North West Territories to the Florida Keys, and westward from the Atlantic to the foothills of the Rockies in such tremendous flocks, was rapidly on the wane. Ornithologists like Wilson and Audubon expressed deep concern over their dwindling numbers, and predicted the pigeons' complete extermination in a few years if the country continued to destroy as it had been doing.

A sensation was created when someone shot a passenger pigeon in 1908. A large enduring female bird passed away in Cincinnati Zoological Gardens in 1914 and its death represented a tragic occasion. It marked the passing of the last of the passenger pigeons on this or any other continent. Indigenous to this American continent, only the occasional bird was ever seen in Europe or elsewhere in the world.

Many of our older citizens, still remembering the pigeon and its amazing gregariousness, speak sometimes wistfully of the delectable meat they furnished, and wonder whatever could have happened to all those millions of slate blue things with long wedge-shaped tails.—(*Forest and Outdoors*, May 1936.)

BACK TO NATURE MOVEMENT

The following has been extracted from a note on Some Recent Silvicultural Developments in Europe, by R. S. Troup, Imperial Forestry Institute, Oxford (British Empire Forestry Conference, 1935).

"Certain unfortunate experiences have produced a marked effect on silvicultural ideas in continental Europe, and particularly in those countries in which pure artificial even-aged coniferous crops have suffered from wind, snow, insects, fungi or soil deterioration. These experiences are largely responsible for what may be termed a new movement, that of "back to nature," which advocated silvicultural treatment based on the biological requirements of species and forest types rather than on the somewhat one-sided mathematical views of Heyer, Pressler and others. This "back to nature" movement is no new idea: it began to take shape in the latter part of last century, under the influence of Gayer, and was gaining more and more adherents before the war. But to a large extent it may be looked on as a post-war development since it is due not only to the unfortunate experiences just described, but also to economic factors which have become prominent since the war. During recent years it has become increasingly apparent that if the demand for timber is to be maintained, its quality must be high, for owing largely to the increasing use of wood substitutes, the demand for low grade timber has visibly declined, a fact which has been aggravated by the recent economic slump. The demand for high grade timber is not likely to derive similar benefit unless new uses can be found for it. The standard set up by the timber exported from North America, Scandinavia, Finland and Russia is still a high one, and other countries are finding that the production of high quality timber is necessary to compete with it.

Another factor which has influenced recent silvicultural development is the need for maintaining the fertility of the soil and increasing the productivity of the forest

and the outturn of timber of the best quality. Adherents of the " back to nature " school hold that this can be secured best by growing mixed uneven-aged woods, subjecting them to frequent thinnings, and relying as far as possible on natural regeneration. Clear cutting and even-aged stands are avoided as something unwholesome, and artificial regeneration is employed only where natural regeneration fails or where the introduction of new species or races is desired, in which case special attention is paid to seed origin. This " back to nature " idea finds its extreme expression in von Kalitsch's *Dauerwald* at Barenthoren in Germany and the selection working under Biolley's *methode du controle* at Couvet in Switzerland, both representing very intensive management of uneven-aged forest. In Switzerland clear cutting and artificial regeneration is being abandoned in favour of the selection or irregular shelterwood (*Femelschlag*) systems with natural regeneration, and pure stands are being converted into mixed ones. Even in the Prussian State Forests a new regulation is coming into operation under which clear cutting and replanting is to be abandoned in favour of shelterwood systems with natural regeneration, and increasing use will be made of mixtures in preference to pure stands.

In this connection it should be noted that although the advantages of mixed crops and natural regeneration are generally recognized in continental Europe, the desirability of aiming at uneven-aged stands is not universally admitted and has in fact its strenuous opponents. The idea of aiming at uneven-aged stands has been developed mainly in countries where snow and wind are factors to be reckoned with, and where even-aged crops have suffered severely from these agencies. The opponents of uneven-aged stands base their opinions on the scattered, and therefore more costly, fellings and regeneration, the branchiness of the trees, and the damage done during felling and extraction. Uneven-aged stands, again, do not always represent the most natural condition of growth, since some species—notably those which regenerate in abundance after a fire—tend to spring up in even-aged masses.

" *Ecological Approach to Silviculture.*"—In connection with the " back to nature " idea, increased attention is being devoted to what has come to be known as the " ecological approach to silviculture," under which ecological investigations are regarded as a necessary basis for sound silvicultural practice. It is no longer considered sufficient to possess a knowledge of the various individual trees and their requirements : the forest has to be considered as a whole, and the mutual reaction of the various trees on each other, on the undergrowth and on the soil, has to be studied. The advances made in soil science in Russia and in ecology in Finland and other northern countries where special facilities exist for the study of natural vegetation have been of value as indicating lines of approach in countries where the course of nature has been to a large extent interfered with by man. The researches of Burger in Switzerland have shown that the structure of the soil is profoundly influenced by the presence of forest, which increases its porosity, its water-storage capacity and its productivity. The view now so widely held in Switzerland and elsewhere that productivity is increased by the adoption of some form of continuous forest in preference to clear-felling, is due in no small measure to this fact.

As a result of recent ecological studies, some of the silvicultural ideas of the past are undergoing modification. To take a single instance, Watt's researches on the ecology of beech woods have shown that beech is not always the soil-improving species that it is supposed to be. He has found that in the relatively uniform climate of south-eastern England, beech woods on certain non-calcareous soils may cause soil deterioration, with increased acidity, the formation of raw humus, and the podosolisation in soils naturally resistant to this process. This change in the soil causes the elimination of ash and a deterioration in the growth of oak and of beech itself. It is clear, therefore, that under the climatic conditions of south-eastern England, the question whether or not beech woods improve the soil depends on local soil conditions. The effects noted refer to woods consisting predominantly of beech, and not to those containing beech scattered among other trees.

TREES

The late Lord Yarborough is said to have planted 11,000,000 trees in 50 years. That sounds a whole lot of trees, but you could plant them comfortably on 20,000 acres of land. Trees are useful things, and it is doubtful if in this country we shall ever have enough of them or the right sort.

If there were a law passed requiring every adult citizen to go out and plant a tree every five years, it would be a wonderful thing. Nature plants, or rather sows, them by the million ; but it is nobody's business to take them up and put them where they would do most good. We have a Forestry Commission, but it only plants fir trees. Oak, ash, and elm, the trees that still make the English countryside what it is, have to look after themselves.—(*Morning Post*, 15th July 1936.)

UPLIFTING THE KORKUS, ABORIGINALS OF THE CENTRAL PROVINCES

BY MOINI

We recently published a Special Rural Uplift Number, and have since received this account of "Uplift" among aboriginal forest tribes of the Central Provinces—the Korkus, of whom the writer has much experience.

The Korkus of the Central Provinces represent a Kolarian tribe of aborigines akin to the Karwas of Chota Nagpur. They are found in these provinces in the districts of Hoshangabad, Nimar, Betul and Chindwara and in the Melghat of Berar. The word Korku simply means man or tribesman, "Koru" being their term for a man and "ku" is the plural termination.

The Korkus are also known as Mawasis which is supposed to signify troubled country and was applied to the hills from where Korku free-booters, led by Rajput chieftains, emerged to ransack the rich plains of Berar, exacting from the Marahatta chiefs the payment known as *tankha mawasi* for the ransom of settled villages. Some people think that the word *mawasi* is derived from mawwa, a tree which provides the drink for which the Korkus have a special weakness.

Although the Korkus are no longer dreaded by the peaceful dwellers of the plains, they still continue to live in their mountainous fastnesses, untrammelled by the worries of modern-day life, still continuing their grim struggle for existence in which *bacilli* and insanitary living serve as great handicaps to them.

They are generally found to-day in the most inaccessible and hilly parts of the Central Provinces, notorious for bad climate. They are remarkably honest and truthful people, very simple in their habits, but very improvident and fond of getting drunk. These habits make them an easy prey to the wiles of money-lenders. Their chief occupations are a primitive form of cultivation and work in forest-cutting and carting of timber, etc. They can really be said to be the children of the forest, as they live in the forest, and depend on the forest for their livelihood. When their crops fail and there are no forest works, tendu, char, aonla and other trees of the forests provide the Korkus with means of sustenance.

WORK OF FOREST OFFICERS

The Government Officers with whom these simple people come into contact most are the Forest Officers. A Forest Officer's life has been described by Kipling in the following words:

> "But since a Forest Officer's business takes him far from beaten roads and regular stations he learns to grow eyes in more than wood lore alone; to know the people and the polity of the jungle, meeting tiger, bear, leopard, wild dog, and all the deer not once or twice after days of beating but again and again in execution of his duty."

It was decided by some Forest Officers to start uplift work amongst the Korkus inhabiting the forests of Nimar District. The following lines of working were chosen:

(*i*) Sanitation,
(*ii*) Improvement of the breed of cattle,
(*iii*) Education, and
(*iv*) Child welfare.

As regards sanitation attempts are being made to teach these people simple sanitary measures like the disposal of filth, keeping the village clean, drinking of well water in preference to contaminated water from any dirty water hole. Medicines, specially quinine, are provided by the Forest Department and distributed freely amongst these simple folk, who have so far known no other treatment for their ill-health except visits to *bhumkas*, the village priests, and resort to witchcraft.

It is obvious that the Forest staff can do very little in this line beyond providing first-aid measures, but even these are producing excellent results.

The Civil Surgeon of the district and his staff are always willing to come to the help of the Forest Department in cases of severe epidemics. It will take a very long time to achieve definite results so far as the improvement of the breed of cattle is concerned but the villagers are being persuaded to purchase better cattle with the

help of the loans advanced by the Forest Department at a nominal rate of interest. As regards education, through the kind co-operation of the District Council, schools are being opened in important centres, so that children from several villages can attend a school.

THEY LIKE BABY SHOWS!

But it is the child-welfare which provides the most interesting work in the movement for the uplift of these Korkus. Owing to the insanitary conditions under which they live, absence of scientific nursing and lack of medical facilities, infant mortality amongst them is appalling. With the object of teaching the Korku women how to keep their children clean so that they will grow fitter and develop better, "Baby Shows" are being held in the most backward tracts of the District—Kalibhit and Chandgarh forests. It is very encouraging to note that the Korkus, men as well as women, are beginning to take great interest in these shows. They attend the shows in large numbers and appear very keen to pick up any instructions given.

All this uplift work amongst these backward and interesting people is being carried out by the Forest Staff in their spare hours as a labour of love. And while the apathy and poverty of the Korkus present serious obstacles and progress is necessarily slow, definite results are already apparent, and it is expected that in due course satisfactory progress will be attained. In other parts of India also the Forest Department can be employed for carrying out uplift work in forest areas where the usual uplift worker, official or non-official, finds it difficult to reach for the present.

Considering the people, their customs and habits, no spectacular results can be expected within a short time, but if the workers have patience and the necessary will to carry on, uplift is bound to be achieved in due course.—(*Illustrated Weekly of India*, 5th July 1936.)

PRIZE DAY AT THE MADRAS FOREST COLLEGE, COIMBATORE, JUNE 1936.

(*Extracts from the Speech of H. E. the Governor of Madras.*)

His Excellency, addressing the gathering, referred to the work of the Forest Ranger in the forest, the nature and responsibilities of his service, and pleaded for the human touch in the working of the departmental machinery.

He added that on an occasion like that, before he referred to the speech made by the Principal of the College and to certain of the criticisms that were levelled against the College and the Forest Department, he thought it was his duty first to congratulate the students of the College who had passed their examinations and had won their prizes which had been distributed to them just then. One thing which he noticed as he was entering the College was the excellent physique of all the students who were standing when he was entering. He must congratulate the Principal on this aspect of the College life which extended to the health and the physical strength of the students. He would have occasion presently to tell them that they needed all the strength and all the learning that they had gained in the College. Their

Principal was telling a little while before, or rather expressed the hope that the students might retain some of the knowledge which they had gained in the College. He would tell him that his experience had been that while the knowledge that they had gained in this College was really good, that which they gained in the field and the forest would certainly be better.

The Personal Element

In the first place, continued His Excellency, they were probably aware that they, the students, were entering the department or were already employed there but their services would be in these forests. Public criticism was very often levelled against this department more than perhaps against any other department. The fact was these critics did not enter these forests. They did not realise the difficulties of the officers of this department, and his young friends who were entering them must be prepared to face such criticisms themselves. The public did not realise that the officers were entering a department where work was confined mostly to the interior of these forests, most of them inaccessible, some infested with malaria, not to speak of wild beasts, away from civilisation, and associated with aboriginal tribes. The difficulties these people had to contend against were not realised by those outside.

Unfortunately these criticisms started with the villagers who had not any idea as to why Government had this forest department, costing about 38 or 39 lakhs of rupees every year, and placed restrictions upon them. Probably the villager would be very grateful to them if they allowed his cattle to graze without paying for it and if they allowed all the drywood, probably even the cut wood, to be removed for the purposes of fuel. But the speaker, when he said all these things, did not mean to say that the officers of the department should be very strict with these people, that they should look only to the revenue of the forests, that they should look to the rules that were placed in their hands and that they should look to the encomiums and praise which they might get from their superiors. What he would suggest without in the least imputing that such qualities were not available now, was that they would have to bring into their administration an element of what might be called humanity, the personal element, the association with the villager, some sympathy with him while they were perfectly right in enforcing all the rules that might have been entrusted to them for execution. That would be his request to them, the Rangers, who were going out and who would be entrusted with those arduous duties.

Forests as National Assets

The trouble with this department was that the public outside did not know that forests were a national asset, that by maintaining and improving these forests they were assisting the agriculturists of the villages in the plains, that they were helping in the retention of the moisture of the soil by increase in the rains and of ever so many advantages which forests alone could give to the agriculturists. Not knowing that and thinking that these forests were there for nothing and that every facility should be given to them, they raised these disputes, these references to Government, with which the officers had to deal. He hoped that when the students

went to these forests as officers, while they conducted themselves in strict accordance with the discipline that had been taught to them here, they would also remember that the villager needed their help and their service.—(*The Madras Forest College Magazine*, June 1936.)

A SIMPLE METHOD FOR TESTING THE HOMOGENEITY OF WOOD

Some time ago we found that there seems to be a characteristic difference in the structure of the wood used for the building of string instruments: X-ray investigations have shown that the top always exhibits a very marked fibre structure, whereas the back in instruments of good tone quality is nearly homogeneous.

The question arises whether it is possible to find these differences by methods which might have been available to the Italian makers of the classical period. I found that it is possible to obtain this information by using heat conductivity in the different directions of the wood as an indicator of its homogeneity. It is well known that a thin layer of wax applied to a crystal face will melt into a figure of definite contour (isotherm) if the crystal is touched at one point with a hot wire. The same method can be easily applied to wood, and one finds that the isotherm on a piece of wood cut vertical to the fibre is always a circle, except where a knot produces an inhomogeneous region. The isotherm on a cut parallel to the grain varies in its outline for different materials. The ratio of the axes for pine used for the top of violins has been found as high as 1·95, and for nearly homogeneous maple used for the back 1·15. We have obtained recently, through the courtesy of Dr. A. Koehler, Director of the U. S. A. Forest Products Laboratory, Wisconsin, some samples of white ash which range, as revealed by X-ray investigations, from very marked fibre structure to almost complete homogeneity. The same variation and exactly the same order has been found by using the isotherm method.

It is possible that such a method, discovered accidentally, may have been used by the instrument makers, since many of the old instruments exhibit branding marks even if the maker did not use a brand for the identification of his instruments.—(*Nature*, 18th April 1936.)

CHECKING OF EROSION

In an extensive programme of gully control it is primarily important that one keeps in mind the permanence of the gully improvements. For instance, if the check dams are built of material that has a comparatively short life, it becomes necessary to provide annual maintenance and perhaps renewal after a few years. Even control structures built of permanent materials require a certain amount of care and maintenance as insurance against possible failures. Check dams built of straw, brush, poles and logs, woven wire, and loose rock usually have a comparatively short life, while dams built of rock or stone masonry, concrete and earth, are of a more permanent nature.

In order to make the results of the work effective in its application to flood control, it is important that control work be not scattered in a haphazard manner over the entire area served by each camp, but that it be confined to a definite watershed. The ideal plan would be to start at the upper end of a watershed and complete all gully control work needed on the watershed, proceeding downstream. A progress map should be kept by the camp superintendent, showing progress and amount of work done on each watershed.

All work done should have some relation to flood control, which may be the result of causing more water to penetrate the ground surface; of preventing the washing away of soil that later is deposited in drainage channels, thereby reducing their capacity and causing overflows, or the storing and holding back of water with the intention of reducing the frequency and duration of floods in nearby bottom lands.

In order that the most effective results and lasting benefits are derived from this programme of gully control work, it is important that only such work as is specified below be undertaken:

1. The construction of large earth, masonry or concrete soil-saving dams capable of controlling and filling large gullies (where the slope is comparatively small and a large amount of storage for water and soil above the dam is created), or at the upper end of a large gully, or an incipient lateral gully where the slope is quite steep to prevent the extension of the gully and the destruction of good land or damage to valuable property.

2. The installation of vertical inlet pipes or boxes at upper ends of highway culverts under high embankments to form large soil-saving dams. This work is to be done with the written consent and co-operation of the country or state officials.

3. The building of check dams of material of a permanent character in small gullies and terrace outlet ditches. Work of this nature should be given preference over the building of temporary dams, whenever the material, such as rock, is available and, on account of the permanent nature of such structure, vegetative work, although desirable, is not required for the permanent protection of the gullies.

4. The building of earth fills where terraces cross large gullies (not less than 3 feet deep) only after the terraces have been constructed. The terraces should be properly laid out and constructed and should conform to recommendations given in *Farmers' Bulletin* No. 1669, or to state publications on terracing. Under no circumstances should such earth fills be built prior to the construction of the terraces.

5. The construction of check dams of a temporary character in gullies for the combined purpose of filling the gullies and to assist in establishing vegetation that will prove effective in controlling the gullies after the check dams become ineffective. Vegetative methods of controlling the gullies should be started immediately, or the landowner should promise faithfully to employ such methods at his first opportunity, and there should be every assurance that the vegetative method as planned will be effective in controlling the gullies. Under no circumstances should dams of a temporary character be built in gullies where no vegetative work is planned. While

check dams of a temporary character are, of course, effective in controlling erosion in gullies, even where systematic vegetative methods are not employed therewith, provided they receive regular annual maintenance and occasional renewal, it is not believed that sufficient assurance can be given that this will be done because of the possible change in landowners, a dwindling of interest, or some such cause.

6. The building of overfall protection works to prevent the beginning of a bad gully or to control the possible extension of existing gullies and their laterals. These overfalls should be built in connection with a large earth soil-saving dam, the object of which is to fill the gully so that a high permanent overfall would not be needed. A lower overfall of a permanent character may later be built if found necessary.

7. The construction of diversion ditches that have for their purpose the leading of water away from the heads of the gullies, thus preventing the drop of the water into the gully with its attendant destructive erosive power.

Methods of gully control.—Methods of controlling and reclaiming gullies are given in *Farmers' Bulletin* No. 1234, entitled "Gullies—how to control and reclaim them." Additional instructions are given herewith to supplement the information given in the bulletin. Curves are included for use in the determination of the sizes of culverts through soil-saving dams, and tables for determining the sizes of notches and spillways in check and large soil-saving dams. Also it is believed that in the present programme, erosion control structures should be built safer than is the usual practice, owing to the fact that the manner in which they will be maintained is rather indefinite. This has accordingly been kept in mind in preparing the accompanying recommendations for check and earth soil-saving dams.

Check dams.—Check dams have for their object primarily the control of gullies to prevent their extension or enlargement and do not as a rule collect an appreciable quantity of soil above them. They are particularly adapted for use in small gullies with comparatively small drainage areas and small run-off. Where they are employed to reduce and control the cross-section of a needed channel draining a comparatively large area, only permanent types of check dams should be used, and more care should be exercised in their construction than when used in gullies with small watersheds.

Dams of porous material, such as brush, logs, loose rock, and woven wire, should, as a rule, be limited to a height of 2 or 3 feet, but may be built as high as 4 feet only when exceptional conditions require such height. The hydraulic pressure of the water on dams increases directly with the height so that the greater the head of water, the greater the tendency to force deposited material through the porous structure of the dam during heavy rains. In general it is cheaper and more satisfactory to reclaim small gullies with low rather than with high dams, regardless of the nature of the material used in construction.

Spacing of check dams in a gully should be such that the fill which accumulates in the gully above the dam extends to the foot of the next dam above. The fill will usually assume a shape of from 6 inches to 12 inches per 100 feet, depending upon the nature of the soil, if there is no vegetation in a gully. With vegetation present, the fill of course will assume a much steeper gradient, depending upon the

density and nature of the vegetation, but to be on the safe side, it is advisable not to rely upon vegetation to maintain a steep gradient.

Particular care must be given to the construction of the check dams at the upper and lower end of a gully. At the upper end the check dam should be built as close to the head of the gully as possible so as to fill the upper end of the gully and prevent any further eating upstream. Mattresses of brush and rock, held by woven wire, box troughs built of creosoted lumber or galvanized metal, and aprons of concrete or masonry are all very effective where the fall into the gully is not too great as is generally the case where check dams are built. The design of check dams built of brush and rock can be modified to suit conditions of overfalls at the head of gullies.

In the construction of a check dam at the lower end of a gully it is especially important to examine conditions affecting the stability of the bottom of the gully. If there is a tendency for the gully to increase in depth due to uncontrolled condition below such as may exist in a large drainage channel, it is necessary that the floor of the apron below the dam be placed deep enough to forestall the possibility of undermining due to probable future changes in controlling conditions below.

From the discussion on hydraulics of erosion control it is apparently important that the drainage area and the water running off be determined before the construction of erosion control structures. The proper size of notches or weirs in the check dams to prevent overflowing of the dam or gully depends upon a correct knowledge of the probable maximum rate of run-off from the drainage area and the water-carrying capacity of the notch or weir.

In the construction of check dams, special attention is called to the necessity of giving careful consideration to the following important points:

1. The reduction in the cross-sectional area of the gully should not be so great as to cause the run-off water to overflow the banks of the gully and thereby cause erosion around the ends of the dam or the development of a new parallel gully down the slope.

2. The ends of the check dams of a watertight character should extend far enough into the gully banks to prevent the possibility of water seeping around the ends and causing the washing away of the side of the gully.

3. The foundation of the bottom of the dam should extend far enough below the bottom of the gully to prevent the hydraulic pressure from forcing water under the dam and thereby undermining the structure.

4. The top of the dam should be low enough in the middle and the sides of the dam should extend high enough up the banks of the gully, so that the water flowing down the gully never exceeds in height the upper part of the sides of the dam.

5. An apron should be provided in the floor of the gully below the dam, of sufficient dimensions in both length and width, to prevent any erosion or undermining of the dam from the water dropping over.

Instructions are given for constructing what is called a "soil-saving dam," the commonest type of dam constructed in India:

"Soil-saving dams, as the name implies, are intended not only to control the extension and enlargement of a gully, but also to collect a deposit of soil and thereby

reclaim an appreciable area for pasture or cultivable purposes. They are accordingly adapted especially for use on larger gullies where a considerable storage is created above the dam which both controls the run-off and thereby floods and tends to prevent deposit of silt in drainage channels and the resulting overflow of bottom lands. Under certain conditions they can be used more effectively than check dams in preventing the extension of the upper end of a large deep gully or the growth of incipient deep lateral gullies.

"A good plan for restoring a large gully, particularly for pasture uses, is to install a soil-saving dam at the lower end, stop the extension of incipient lateral gullies and the upper end of the gully, plow in and smooth down the side slopes, and seed the slopes and bottom to pasture grasses or other vegetation. In order to promote the rapid growth of grass in the bottom, a line of drainage tile discharging into the vertical inlet culvert should be laid down the bottom of the gully. The vegetation in the gully tends to check the velocity of the water and to strain out particles of soil. The result is that the bottom of the gully acquires a steeper gradient and soil is deposited in the gully for a greater distance above the dam."—(*Extracted from U. S. Deptt. of Agriculture Pamphlet on "Gully Control."*)

The following information is extracted from the *Seaborne Trade and Navigation of British India*, for July 1936—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	MONTH OF JULY			MONTH OF JULY		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER				R	R	R
Deal and pine wood . . cubic tons	435	868	1,051	28,272	59,139	59,595
Teakwood—						
From Siam . . cubic tons	200	. .	110	22,155	. .	15,692
„ Indo-China „	. .	. .	57	. .	. .	7,232
„ Other countries „	. .	. .	. .	. .	22	. .
Total . . „	200	. .	167	22,155	22	22 924
Sandalwood . . . . „	2	23	10	1,353	6,762	5,265
Other kinds of wood and timber, including firewood, timber for match-making and plywood, etc. „	. .	. .	. .	71,695	1,13,424	55,696
Manufactures of wood, including wood-pulp and tea-chests *other than* furniture and cabinetware . . „	. .	. .	. .	5,37,761	7,21,296	3,39,711
Total . .	. .	. .	. .	6,10,809	8,41,482	4,00,672
Total of Wood and Timber „	. .	. .	. .	6,61,236	9,00,643	4,83,191

EXPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of July			Month of July		
	1934	1935	1936	1934	1935	1936
Wood and Timber—						
Teak wood—				R	R	R
To United Kingdom, cubic tons	3,706	3,835	2,332	8,74,384	7,51,453	4,93,664
,, Germany .. ,, ,,	352	327	327	91,035	71,970	76,967
,, Belgium .. ,, ,,	70	143	42	13,424	30,806	5,040
,, Iraq .. ,, ,,	122	261	76	24,206	42,850	18,548
,, Ceylon .. ,, ,,	27	35	28	3,363	5,164	3,807
,, Union of South Africa .. ,, ,,	118	351	222	30,352	60,386	40,507
,, Portuguese East Africa .. ,, ,,	7	110	112	1,225	19,502	20,084
,, United States of America .. ,, ,,	88	68	52	26,491	16,858	15,641
,, Other Countries ,, ,,	714	484	359	1,69,534	97,062	68,276
Total .. ,, ,,	5,204	5,614	3,550	12,34,014	10,96,051	7,42,534
Share of Bengal ..cubic tons	..	..	..	..	..	..
,, Bombay .. ,, ,,	199	270	88	49,250	42,639	19,058
,, Sind .. ,, ,,	..	..	..	..	..	..
,, Madras .. ,, ,,	..	..	27	..	..	7,049
,, Burma .. ,, ,,	5,005	5,344	3,435	11,84,764	10,53,412	7,16,427
Total .. ,, ,,	5,204	5,614	3,550	12,34,014	10,96,051	17,42,534
Teak Keys .. tons	569	494	129	74,610	72,450	17,700
Hardwood (*other than* teak) and manufacture of wood *other than furniture and cabinet-ware*	..	..	..	60,686	24,397	71,755
Total ..	..	..	..	60,686	24,397	71,755
Sandal wood—						
To United Kingdom .. tons	6	..	..	8,250	..	..
,, China (*excluding* Hong-Kong) .. ,,	20	..	9	30,525	..	11,230
,, Japan .. .. ,,	22	5	5	26,201	5,920	5,500
,, Anglo-Egyptian Sudan ,,	8	5	8	8,510	5,400	8,360
,, United States of America .. .. ,,	50	61	..	60,000	62,810	..
,, Other Countries .. ,,	5	4	3	10,275	3,965	5,385
Total .. ,,	111	75	25	1,43,761	78,095	30,475
Total of Wood and Timber and Manufactures thereof ,,	..	..	..	15,13,071	12,70,993	8,62,464

VOLUME LXII 725 NUMBER 12

INDIAN FORESTER

DECEMBER, 1936

REGENERATION OF GURJAN, DIPTEROCARPUS SPP. (NATURAL AND ARTIFICIAL)

BY J. N. SEN GUPTA, EXPERIMENTAL ASSISTANT SILVICULTURIST, F. R. I.

ABSTRACT.

The nine species of *gurjan* occurring in India (excluding Burma) and the Andamans have been mentioned with reference to their general habitat, distribution in recognised types of forests and local occurrence. They exhibit importantly common silvicultural characters and behave somewhat similarly towards reproduction, except one or two, whose deviations have been mentioned. Results of experiments to date giving definite indications have been incorporated in suggesting proposals for different provinces as regards the future treatment of their potential *gurjan* forests mainly from the regeneration (natural and artificial) point of view with details of the technique as evolved so far.—*J. N. Sen Gupta.*

1. *Introduction.*—*Dipterocarpus* is a most important timber-producing genus found over the whole Indo-Malayan region, having apparently originated in Western Malaysia in early Tertiary or late Mesozoic times, and since migrated eastwards to the Philippine area, and north-eastwards, through Burma, into India, all forming then an unbroken continent.

2. In India (excluding Burma but including the Andaman Islands) there are nine species, well known by the vernacular generic name *gurjan* (with other different local names such as *dhuma, kalpayin* or *vellaini* in the Western Ghats, *hollong* in Assam, and *kanyin* in Burma and the Andamans)—all of which are considered to be more or less first-class general utility timbers. Given preservative

treatment, they have been pronounced to be equal to or perhaps better (*e.g.*, in teredo-infested waters) than the best Indian timber of sal, teak or deodar for general constructional purposes or for railway sleepers.

3. Curiously enough, the historical background of the genus *Dipterocarpus* points to its discovery in the East as far back as 1750 by Rumphius, a Dutch Botanist, not as a timber tree but as the wood-oil tree, containing an essential oil which was made to flow by cutting a hole in the stem and burning a fire therein. The oil was used for making torches and for caulking boats and ships. The value of its timber was only gradually recognised long afterwards, although the original *gurjan*-oil still holds its own in the commercial market both in India and abroad. Even during the beginning of the present century *gurjan* timber had but an unimportant place in the local timber marts, being used for general constructional purposes or experimentally for railway sleepers where more valuable species were difficult to obtain, until emergency demands during the Great War pushed it to the fore, and its commercial value has since been steadily on the increase.

4. Consequently the silvicultural aspects of conserving and improving the *gurjan* forests of India and the regeneration problems presented by them have now been engaging the serious attention of local forest officers since that time.

5. During the quinquennium 1930-35, the writer was in close touch with all the technical details of *gurjan* regeneration work in South Bengal where it may be said to have just passed the experimental stage. The experience thus gained was supplemented by an instructive tour, early in 1936, in the Western Ghat forests of Madras, Mysore and Coorg and in the Andaman Islands. Except some areas in relatively dry localities to the southern extremity of the district of Chittagong in Bengal adjoining the Arakan frontier of Upper Burma characterised by comparatively gregarious types of *gurjan*, all the remaining *gurjan* areas in India (outside Burma) occur in the tropical evergreen or semi-evergreen forests where the various species of *gurjan* are mostly of sporadic distribution. *Gurjan* is the predominant

Dipterocarpus alatus. GIRTH AT BREAST-HEIGHT 30 FEET. HEIGHT ABOUT 150 FEET. MIDDLE ANDAMANS.

By B. S. Chengappa, 1935-36.

species in the topmost canopy where it occurs, but there is always a varying proportion of other component species (irregular in height) forming the main canopy. Although this article refers primarily to *gurjans*, the presence of their associates has not been lost sight of, and the treatments prescribed for the *gurjans* will generally be applicable to the other specially important timber species occurring in the same types of forest and shewing somewhat similar silvicultural characteristics. Their respective proportion in the future crop is a consideration for management.

6. *Species and their distribution.*—Out of nine different species occurring in India, the Andaman Islands contain the most, as many as five, *viz. Dipterocarpus alatus, D. costatus, D. pilosus, D. grandiflorus* and *D. kerrii ;* Bengal, the next, has four species, the first three mentioned for the Andamans, and *D. turbinatus,* our knowledge of which has, from the regeneration point of view (especially artificial), advanced considerably further than all others ; Assam, the third in order, contains the last-named species in areas contiguous to Bengal, and another species *D. macrocarpus**, the commercial *hollong ;* and lastly the Western Ghat forests of Mysore, Coorg and Madras have only one species, *viz. D. indicus.* The other Indian species *D. bourdilloni* (somewhat resembling *D. alatus*) has so far been found only in Travancore.

7. In their natural habitat, these lofty trees towering above all others are recognised as the " monarchs " or " giants " of the forests, with long, clean, straight and cylindrical boles often unbranched to a considerable height, and elevated round-headed crowns. Their average heights vary between 100′ and 150,′ and girths between 10′ and 15′—still remaining sound ; and, even bigger trees are not very uncommon.

8. *Climate.*—The average rainfall in *gurjan* areas exceeds 100 inches during the year (an abnormal maximum of 350 inches only locally in the Western Ghats), resulting mostly from the south-west

*Kanjilal and Das recognise *Dipterocarpus manii* as a distinct species in Assam (Sibsagar and Lakhimpur). This plant is not well known and appears to be very closely related to *D. macrocarpus*.

monsoon which normally bursts early in June and continues till September, with occasional winter rains (of the retreating monsoon); storms occur at intervals, followed later by intermittent pre-monsoon showers between the second half of April and May. The three months between January and the first half of April are the driest period during the year, the latter part being a pronounced hot season in some localities. There are no great extremes of temperature—the climate being in most places tempered by cool breezes—and the cold season is short, when heavy dew forms and dense mist hangs over the rivers at night. Humidity is high and relatively uniform.

9. *Topography, rock and soil.*—The terrain of *gurjan* areas is very irregular, and the elevation varies between 25 ft. and 2,000 ft. for most of the *gurjans*, except *D. indicus* whose upper limit is a little over 3,000 ft. The underlying rock is mostly Upper Tertiary sandstone and conglomerate in Assam, Bengal and the Andamans, and granitic gneiss in the Western Ghats; the resultant soils are fairly deep, fertile, sandy to clayey loams, ferruginous in places and tending to harden on flats.

10. *Types of forest.*—The *gurjan* areas in the provinces can be classified into two broad types, *viz.* (*i*) the *sporadic type* and (*ii*) the *gregarious type*,—the former being more common. In general, the species of *Dipterocarpus* are semi-gregarious in habit, and the two terms are relative. The sporadic (or occasionally gregarious) type of *gurjan* refers practically to all the Indian species mentioned above except two, and occurs in what is commonly known as "Tropical Wet Evergreen or Rain forest" in India. This type of forest is characteristic of warm tropical parts with heavy (at least 80 inches), well distributed rainfall, high atmospheric humidity and usually without any great extremes of temperature or prolonged dry season. It is the most luxuriant type of lofty evergreen forest composed of numerous evergreen species mixed together. The scattered giants (150 ft. or more high) with their long, clear and cylindrical boles project well above the extremely dense general canopy whose further differentiation into rigid canopy layers is difficult, although broad local classifications into two or more overlapping storeys or tiers

Dipterocarpus costatus. NEAR HARBHANG, CHITTAGONG HILL TRACTS, BENGAL.
(*P.* 439.) *H. G. Champion*, 8-2-26.

are perhaps permissible. Gregarious dominants are rare, while a few species are semi-gregarious locally but not typically. Many of the trees have thin, smooth bark and plank buttresses at the base. There are a large number of herbaceous epiphytes, especially aroids, ferns, mosses and orchids. Grasses are absent and the undergrowth is often a tangle of canes, creeping (or locally erect) bamboo and palms. The presence of bamboos usually suggests a pre-climax condition. Cauliflory is relatively common. The leaves are of very diverse forms, often firm, thick, leathery and glossy. There are thick-stemmed climbers of varying amount but less than in the semi-evergreen and moist deciduous types.

11. The above description is applicable to the climatic climax type of evergreen forests (virgin or otherwise) of Upper (and partly Lower) Assam, South Bengal (mainly Chittagong Hill Tracts), Andamans Hill evergreen and the Ghat crest of the West Coast, which abound in practically all the *gurjans* under reference, though they are infrequent in the Western Ghats except in localised moist situations, *e.g.*, in Coorg and Mysore.

12. The relatively gregarious type is represented in the typical *gurjan* (*D. costatus*) forests confined to the rather drier lower half of the Chittagong Collectorate and adjoining Hill Tracts (S. Bengal), south of the Sungoo river and not far off but almost parallel to the coast of the Bay of Bengal. These are typically on the red-soiled elevated *tilas* and low hills especially on north-east to eastern aspects on the ridges. These forests gradually merge into the Arakan borders of Upper Burma and represent a less mesophytic form than the Tropical Evergreen ; such form may as well be conditioned by a drier climate, drier soil, or by biotic factors including fire. The *gurjan* trees here are not as fine as in the wet evergreen, and are hardier than their associates. The type is probably not a climax, but appears to have originated through human influences acting on the climax evergreen or semi-evergreen type. The occurrence of the characteristic species *D. costatus* is, however, altogether fortuitous, as it is also found scattered in the dense virgin forests of the Andamans. This species can stand exposure to wind and generally less favourable

conditions of soil and climate than the main climax form (although the rainfall is usually high—over 100 inches).

13. The above two broad types overlap, giving rise to intermediate types of tropical mixed, sub-or semi-evergreen forest which occupy by far the largest area in South Assam, South Tipperah, Chittagong Collectorate and Hill Tracts (Bengal), where the predominant species of *gurjan* is *D. turbinatus*. The forest is dense, storeyed, and high but less lofty than the typical evergreen.

14. The general structure of the crop is fairly uniform in each of the three types, composed of 4 more or less distinguishable evergreen tiers or storeys, interlaced by heavy climbers, in the tropical wet evergreen; of 3-storeys of which the topmost of partly evergreen and partly deciduous species in the gregarious (moist tropical) *D. costatus* type; and of 3-to 4-storeys with a majority of evergreens in the uppermost canopy in the intermediate sub-evergreen type. In the relatively dry xerophilous type, invasion by grass and bamboos gradually displaces and limits the evergreen annuals and perennials of the undergrowth including climbers. These grasses and bamboos cause severe periodical fires and are reciprocally occasioned by the latter; while fires do not, as a rule, enter the truly evergreen forests.

15. As regards natural regeneration, young trees of the valuable species are generally deficient in numbers, except in some of the evergreen forests where a fair amount of sapling regeneration can be found in dense patches which are decidedly local in their distribution.

16. *Leaf-shedding, flowering and fruiting.*—None of the *Dipterocarpus* species are, strictly speaking, deciduous, although *D. costatus* may be locally so for a very short time, just before the new foliage and flowers appear. For all species, the leaf-shedding period is quickly (almost immediately) followed by the appearance of the new foliage in the cold season.

17. Large, showy and somewhat scented flowers, adapted for insect-pollination, appear in winter. Fruits of *D. alatus*, *D. costatus* and *D. macrocarpus* appear sooner than those of the rest. The earlier immature fruits appearing from February onwards are destroyed by hordes of parrots, followed by severe insect attack

(weevils and other grubs); the later ones are comparatively free from these injurious elements and are mature about the right season, normally just before the monsoon. In the majority of cases, the light immature winged fruits are dispersed by the early pre-monsoon storms towards the end of the hot season—the heavy mature ones falling at the commencement of the rainy season just in time for germination almost at once. Seed is produced to some extent every year while good seed-years occur at frequent intervals, which, if followed by timely rains, result in an abundant crop of seedlings.

18. *Germination, conditions favourable to stem development and silvicultural characters.*—The *gurjan* fruit with its two elongated wings drifts to the ground like a shuttle-cock below and to some distance around the seed-bearers. The most essential requirement for germination is moisture in soil and air, and germination under wet conditions may take place even when the fruits are on the trees or caught up on the slash or litter. Germinating fruits, if carefully handled, can be successfully sown during the rains.

19. Germination is hypogeous: the radicle emerges from between the wings and curves rapidly downwards, soon forming a taproot; the cotyledonary petioles meanwhile elongate to a length of about an inch, enabling the plumule to emerge from between them; the thick fleshy cotyledons remain within the fruit. The nursery and plantation practice in most places is to place the seed (while dibbling or notching) on its side just as it lies naturally on the forest floor; but experiments made in Burma (1919-20) with *D. alatus* shewed that when seeds were buried one-third of their length in the ground, *apex downwards* (*wings clipped*) *and stalk end up*, they germinated freely. This was supported by Malayan experience as well. It was contended that sown thus the radicle went straight into the ground, while in a reversed position germination took more than two months, and if the wings were left attached the seeds were easily moved by wind and rain.

20. A clean germinating bed, provided by an initial burning or removal of the slash (and leaf litter) where possible, and a well-drained soil not subjected to bad aeration, are essential requirements

of the germinating seedlings. The growing plant also needs light for its development. This light may be either full or diffused, the former as in the open nursery or plantation areas in evergreen types where the moisture content in the soil is relatively high, and the latter in natural regeneration areas under high shade or in plantations in semi-evergreen or moist deciduous types, where a nurse-crop like *Tephrosia candida* or *Gmelina* is introduced to afford the diffused shade either from above or from the side, incidentally slowing down or preventing desiccation of the surface soil.

21. The *gurjans* are light-demanders, strongly so and exacting, once the plant has been established. In the natural forest, seedlings and saplings do, however, persist and stagnate for years in a suppressed condition under the heavy multi-storeyed shade, and to that extent the *gurjans* are shade-bearing (though not shade-demanding); and if there is a break in the canopy either by accident or by authorised fellings, the apparently suppressed plants recover and shoot their heads up in their upward race for light. Strict fire-protection of the regeneration area and early weeding (of creepers in particular) are absolutely necessary; the *gurjans* are not generally fire-resistant.

22. The chief injurious factors to regeneration are (*i*) long and intense suppression from above which dwarfs the leaders and invites shoot-borers (Assam and Bengal), (*ii*) drought, particularly in localities where there is a pronounced dry period and the soil is shallow with hard impervious crust, (*iii*) fire, and (*iv*) climbers. As a rule, *gurjan* does not coppice, except *D. costatus* to a limited extent.

23. *Natural regeneration.*—The *gurjan* areas in the three types of forests described above, *viz.* (*i*) the tropical (wet) evergreen, (*ii*) the intermediate mesophytic or sub-evergreen with *D. turbinatus* and (*iii*) the moist tropical or the gregarious *gurjan* (*D. costatus*), are somewhat different even in their behaviour towards natural reproduction. While *gurjan* regeneration (with other important species) springs up in profusion under and around seed-bearers in type (*i*), and irregularly in suitable localised patches in type (*ii*), reproduction

is very poor to almost completely absent in type (*iii*), where the soil is comparatively hard, the seed-crop is insect-attacked and its fall premature. A seed-crop of good promise may be wholly or partially destroyed, firstly by parrots and insects, then by early storms and hail before maturity (*e.g.*, *D. alatus*. *D. costatus* and *D. pilosus*).

24. The favourable factors contributing to the natural reproduction are (*i*) annual sporadic seeding and abundant biennial or triennial crop of seeds, (*ii*) adequate seed-dispersal by high winds over at least a 100 ft. radius around each seed-bearer (the smaller the seed, the wider the dispersal and *vice versa*, *e. g.*, small *D. costatus* versus big *D. grandiflorus*), and (*iii*) commencement of the monsoon rain at the right time soon after seed-fall. Late monsoons may, however, cause a total failure in germination. In very damp localities with bad drainage (*e.g.*, some areas in the Agumbe zone, Mysore) or in hardened soil (Cox's Bazar, Bengal), the radicle sometimes rots during the process of germination ; in the gaps, full of undecomposed litter of dead leaves, etc., germinating seeds cannot readily get a hold on the soil, and perish rapidly ; and, almost the same adverse condition is caused by heavy growth of grass or dense whips of bamboo in the lowest storey, with the result that natural reproduction in such areas is conspicuous by its absence unless the hindering soil cover is burnt, cleaned or otherwise reduced by fire, grazing or slashing, etc., as an aid to reproduction.

25. As regards the establishment of seedlings, experiments in Bengal, Coorg and the Andamans (as well as in Burma and Malaya) have indicated that the admission of full *overhead light* is necessary for the best development, but it has to be done by stages at a rate calculated to keep the rank growth of weeds (including climbers and grass), which are also stimulated by improved conditions of light, definitely in check. To effect this the canopy over regeneration is lightened from below, working gradually upwards,—the intensity and frequency being determined by local conditions as the seedlings respond to the operations and establish themselves. In this way existing weedgrowth is not unduly stimulated and light-demanding

species do not invade the area until the regeneration of important species can be got into a condition when it can compete with the heavy weedgrowth which is the inevitable consequence of opening up the higher canopy layers by commercial fellings.

26. Indian experience from experiments based on reports on work done in Malaya favours the gradual opening of the canopy from the ground upwards, leaving the top canopy intact till last. Meanwhile, recent Malayan experience is reported as indicating that such operations alone do not fulfil all the requirements of inducing natural regeneration and that the top canopy must also be disturbed initially, by fellings of valuable species with a view to provide suitable light-conditions and to minimise subsequent felling damage. Personally, I agree with the latter view and maintain that although theoretically these two views are different, in practice they are the same ; as, in India we have hardly started any regeneration fellings in any typically virgin (undisturbed) forests that have not, some time or other, been subjected to selection fellings (though irregular) of the top-storey timber species and thereby brought into the same condition as advocated by the Malayan foresters. South Bengal, Coorg and the Andamans, the three big centres of natural regeneration experiments in India. answer to this description, for exploitation fellings of one sort or another have been going on in these evergreen forests. And experiments in the typically virgin evergreen forests have not yet given any results disproving the above conclusion.

27. *Artificial regeneration.*—The only province where artificial regeneration has passed the experimental stage, attained some reasonable measure of success, and standardised some definite technique, is South Bengal, mainly with the species *D. turbinatus* that seeds well normally with the break of rains, and germinates profusely. The three other Bengal species which seed comparatively early to be blown off by high winds or attacked by parrots and insects while still immature, have not so far given encouraging results, except with tender care in the nursery. Difficulty has been the greatest with *D. alatus* which seeds earliest of all. In some years of early monsoon I have noticed seeds of *D. costatus*, and some times *D. pilosus*,

Dipterocarpus alatus. NATURAL REGENERATION, FIRST OPENED UP IN 1933, OVERWOOD GRADUALLY REMOVED. GUITAR ISLAND 1933 EXPERIMENTAL AREA, MIDDLE ANDAMANS.

By B. S. Chengappa, 1935-36.

Dipterocarpus turbinatus. 1928 PLANTATION, 3 YEARS 9 MONTHS OLD, SOWN IN LINES 6′ APART. BHOMORIAGHONA, COX'S BAZAR DIVISION, BENGAL.
By C. K. Homfray, February 1932.

germinating profusely *in situ* which did fairly well when carefully planted out. Of the crop the first fruits that fall are discarded, the more fertile ones take a little longer to mature and later collection of fruits is always preferable for all species of *gurjan*.

28. The present practice in Bengal is to raise *D. turbinatus* mainly in *taungya* plantations by direct dibbling thickly in 2 or 3 rows at the end of May to the beginning of June of *hand-picked* seeds, in one-foot-wide hoed-up lines or strips which are 6 ft. apart, with a nurse crop of *Tephrosia candida*, introduced during mid-July and early August in the interspaces (at 15 to 20 seers of seed per acre), as soon as the final cleaning to the field crop (paddy) has been completed ; blanks for *Tephrosia* are infilled in September after the paddy has been reaped. Earlier sowing of the *Tephrosia* would interfere with and swamp the field crop. Where *taungya* is not feasible, the method is departmental plantations on similar lines, but by introducing *Tephrosia* broadcasted fully or in hoed-up lines or strips (1 foot wide) running centrally between the *gurjan* lines early in May in advance of the *gurjan* sowing. In either case rains-weeding is done to help both *gurjan* and *Tephrosia* plants. The latter has a double function of preventing the invasion by weeds (especially *Eupatorium odoratum*) and, as a nurse, to protect the young seedlings from drought specially during the first two hot weathers when the ground gets very dried out. By timely cleanings, trimming, lopping of side branches and thinnings as required during the first two years, the *Tephrosia* is never allowed to overtop the growing leaders of *gurjan*. The beneficial side shade, as opposed to overhead shade, is maintained by pruning the *Tephrosia* in the third year and a little higher up in the fourth also, if required, by which time the *gurjan* plants with an average height of 6 ft. have established themselves against the harmful effects of interfering weeds. The cost of these plantations has so far been worked out to be about Rs. 30 to Rs. 35 per acre for the first 5 years.

29. In the moister evergreen forests of the Chittagong Hill Tracts (Mainimukh), very successful *gurjan* plantations were raised with *taungya*, absolutely in the open without any *Tephrosia* which

was, however, introduced later to keep down weeds. Drought is not a serious problem there as in the Collectorate, but weedgrowth is very rampant and frequent cleanings have to be done.

30. *Mixtures.*—To obviate the rank growth of weeds and as a complementary to the *Tephrosia* method (to compare relative costs) and also due to the present tendency of raising mixed plantations instead of pure crops, alternate lines of *Gmelina* and *gurjan* have, since 1931, been experimentally raised in the Hill Tracts, *Gmelina* at stakes spaced 6 ft. apart in the lines which are 12 ft. apart, and *gurjan* sown in continuous lines running centrally in between the *Gmelina* lines. The treatment of the *Gmelina* was subordinated to *gurjan* which would eventually form the major final crop. Another method very recently employed (as an off-shoot of the former) with a view to reducing the cost of cultural operations is to arrange *Gmelina* and *gurjan* lines in alternate strips of 3 and 5 lines respectively.

31. Owing to the very serious damage done to the older plantations by *Loranthus*, *Gmelina* has been entirely dropped as a pure crop, but is being treated as a nurse to the slower growing *gurjan* with a possibility of retaining a few stems as part of the main crop. The ideal practice for the choice of different species of *gurjan* according to different sites would be to put out *D. turbinatus* and *D. pilosus* on the mid-slopes, *D. costatus* on upper slopes and ridges and *D. alatus* lower down at the foot of hills, on the analogy of their relative position in the natural forest. But this cannot be rigidly followed as the quality and quantity of available seed would eventually determine the final distribution of site and area.

32. *Proposals for future.*—Little attention has been given in the past to the problem of regeneration in evergreen forests including *gurjan* areas due mainly to (*i*) lack of communication, (*ii*) limited local demand, (*iii*) want of outside markets and (*iv*) extensive Unclassed State Forests in Assam and Bengal meeting the local demand, besides varying proportion of their component species (major and minor) whose silvicultural requirements are not well known. The economic aspect of regeneration technique is of primary

consideration, which again depends on two conditions, *viz.* (*i*) a sustained demand for major produce of the existing growing stock and its economic exploitation, and (*ii*) availability of the requisite labour to work and the staff to supervise.

33. *Silvicultural system.*—The system of management of *gurjan* (including evergreen) forests has so far been an irregular selection system with or without improvement fellings, over an exploitable girth limit, but carried out mainly at the bid of the exploiter, outside or departmental.

34. The 1922-23 Working Plans in South Bengal prescribed the "Floating Periodic Block" system with a provisional conversion period of 80 years, and only P. B. I. was selected to be regenerated by clear-felling and planting and successive regeneration fellings in 20 years. Selection fellings were also prescribed in areas outside P. B. I. Later opinion was that as P. B. I. had not been well defined for want of a detailed stock-map, such elaborate plans were premature, and a simple working scheme should meet the requirement under which regeneration fellings should be allowed in any part where labour or other conditions justified it; in the remainder climber-cutting and improvement fellings, and over-mature trees to be removed wherever they occur, particular attention being paid to assisting pole crops of valuable species. The present system in the Andamans is a conversion to the Uniform system, whereby although selection fellings subject to girth limits will continue to be carried out, a definite area is allotted for regeneration into a new even-aged crop. Coorg has just adopted a modified selection system (preceded by climber-cutting), followed by improvement fellings and cleanings where regeneration exists and artificial regeneration where it is lacking, with a felling cycle of 50 years.

35. Statistics determining the rate of growth are very inadequate and not dependable. From some ring-countings on stumps (ring-counting of *gurjan* is very difficult and misleading) South Bengal computes that mean annual girth increment of *gurjan* is 1 inch, while Burma gives a figure nearing 0·7 inch and the Andamans a very much lower figure. Assuming that the Bengal figure is an exaggerated

one but that a properly tended crop would give a higher figure than Burma or the Andamans, an estimated mean annual girth increment of 0·8 inch may not be very inaccurate, on which basis a rotation of 120 years for an exploitable girth of 8 ft. may be a safe provisional estimate to work with. (The present exploitable girth of *gurjan* is 7 ft. 6 in. in Assam, 7 ft. in Bengal, 8 ft. in Mysore, 6 ft. in Coorg and 9 ft. in the Andamans).

36. In view of the scattered advance growth irregularly distributed all over the potential *gurjan* forests a "floating periodic block" system is recommended with an assumed conversion period of 80 years. The area allotted for natural-*cum*-artificial regeneration during the period of 15 or 20 years of the plan need not be a fixed proportion of the total area of the Working Circle. At the termination of the working plan period, all compartments which have been regenerated and *in which final fellings have been carried out* will be thrown out and some unallotted compartments will be transferred to the regeneration block. The proportion of the regeneration area to the total area of the felling series may vary at subsequent revisions of the plan,—the regeneration period being altered proportionately. A detailed and careful stock-map of the growing stock should first be made with a view to indicating correctly what areas should constitute the regeneration block, with an eye to accessibility of labour and supervision, concentration of work and economic exploitation. In the remainder, the stock of over-mature and deteriorating trees should be removed, leaving seed-bearers spaced at least 66 ft. to 100 ft. apart under selection-*cum*-improvement fellings (by coupe-system) over an exploitable girth of 8 ft. and the existing advance growth of all ages assisted as best possible.

37. The areas under the regeneration block should then be sub-divided into (*a*) where adequate natural regeneration of important species is already present ; (*b*) inadequate natural regeneration, but likely to show more recruitment with improved conditions ; and (*c*) little or no natural regeneration and no likelihood of recruitment.

38. *I. Natural regeneration.*—In (*a*) above, the existing natural regeneration should be assisted and further recruitment induced,

joining up gaps by timely even dispersal of seeds (dibbling or notching, if necessary) in the manner proved successful in the Andamans and elsewhere, as described above. The overwood canopy must be lifted from below upwards as rapidly as local conditions of growth permit, consistent with the progress of regeneration and the necessity for keeping down weeds. Light and space introduced in this way will benefit tree seedlings and saplings without over-stimulating weed-growth. Final felling must not be delayed unduly.

39. *II. Natural*-cum-*artificial*.—In (*b*), a method of natural-*cum*-artificial regeneration should be adopted, assisting the existing and inducing further recruitment and notching in seeds of *Dipterocarpus*, 3 ft. by 3 ft. at the right season. As the main canopy is mostly composed of mixed species other than *gurjan* which exhibit silvicultural affinities to the latter, any cultural operations primarily intended for *gurjan* regeneration are bound to affect regeneration of the other species also. The natural-*cum*-artificial method would accordingly aim at obtaining a varying proportion of the important component species in the future crop.

40. In both *I* and *II*, preliminary operations in the canopy are more or less the same, *viz.* starting from below and working upwards quickly or gradually as local conditions require. Climber-cutting, and in truly virgin forests a light selection felling in the overwood, are necessary preliminary operations, prior to any of the treatments mentioned below. The initial treatment is that the lowest storey must be removed by slashing all undergrowth of inferior species, leaving, however, promising seedlings and saplings of valuable species, that the lower middle storey of valueless species is also to be felled (smaller trees) and girdled, leaving only the topmost storey and such of the upper middle as are required to maintain an evenly balanced high canopy. Low shade is definitely harmful; and where shade is from two layers of canopy, the lower canopy is to be removed including judicious thinnings of pole crop of important species. If the existing regeneration is not enough and localised and their condition lanky and moribund without any future (as a result of long suppression), they can be sacrificed and the area burnt under

control early in April, protecting seed-bearers by scraping the slash away from the base. After the final seed-fall the area should be carefully gone over and odd blank patches broadcasted or better dibbled with seeds by notching. Once regenerated, the area is to be effectively fire-protected, and one (or two, if necessary) intensive weeding has to be carried out during the rains. Future cleaning should only remove weeds actually interfering with the plants. The overwood is to be gradually removed by girdling and felled finally (when saleable) as the plants are established.

41. *III. Artificial regeneration.*—In (*c*), clear-felling and artificial regeneration by the *taungya* method with a nurse-crop or in mixture with a fast-growing species like *Gmelina* is recommended, on the lines of Bengal. The existing stock must be economically exploited to the utmost possibility and clear-fellings must be limited to the area which can be successfully planted up. If, however, *taungya* is not practicable but other cheap and efficient labour can be available and good and frequent supervision assured (as at Bhomori-aghona) departmental plantations may also be recommended.

42. In all the above three cases, the practical and economical considerations of the sale of the produce are of great importance. From the purely regeneration point of view labour is the deciding factor; also the requisite staff for supervision which must be very thorough until the plants have established themselves. Very many experimental attempts have been known to have failed mainly due to its lack rather than to any natural causes.

43. No transplanting or stump-planting is recommended and success must be obtained in the first year as it becomes very difficult to beat up blanks in subsequent years.

44. From the point of view of present conditions in provinces it is recommended that Upper Assam should take up No. *I*, South Assam mainly Nos. *III* and *II*, South Bengal all the three according to localities, including No. *II* in fuel coupes, Mysore Nos. *I* and *II*, Coorg No. *I* and experimentally on a small scale No. *III* also, Madras West Coast No. *III* and experimentally No. *I* for all evergreen species, and the Andamans No. *I* only.

45. Coorg and some other provinces may not be able to work their evergreen *gurjan* forests on any regular system of concentrated regeneration fellings on account of peculiar market and administrative conditions at the moment. But any of the above methods (specially Nos. *I* and *II*) can be applied to the system in vogue, *viz.*, the modified selection system followed by improvement fellings, which by a light initial break in the canopy assists and induces natural regeneration.

46. In deciding between the natural and artificial regeneration, the economic aspect is the main determining factor. Natural regeneration is not to displace the artificial where the latter is cheaper, but these two methods are to supplement each other, the natural being confined to more inaccessible areas where sales are bad and logging operations difficult, and the artificial to accessible areas where exploitation and labour are comparatively easy to control.

ROOT SUCKERS OF SEMAL

(*Bombax malabaricum*)

By L. B. Holland, Conservator of Forests, C. P.

In the South Chanda Division, which lies at the extreme south of the Central Provinces, semal is a fairly common tree, especially in the Dhaba Range where with *bija* (*Pterocarpus marsupium*) and a number of valueless species it forms extensive forests. Here semal from 2 ft. to 4 ft. girth are plentiful, trees from 14 inches to 3 ft. numerous and during the rains seedlings abundant, but regeneration from the seedling of about ten months to the tree of one foot girth is entirely absent.

The problem is to discover why seedlings here do not persist and why elsewhere, as in the adjoining North Chanda Division, the fleshy rootstock persists but the annual shoot dies back every year during the hot weather. In the North Chanda Division is a forest with similar soil conditions but a far lighter canopy, where during the rains the ground is carpeted with seedlings. Dig one up and it may be a true seedling or it may be seen that the shoot of the year is a few inches

high, sprouting from a fleshy rootstock which may be eighteen inches long with a regular girth of three inches for its whole length. At the top of the root are the scars, often seven or eight in number, left by the shoots which have died back year after year.

The question is what are the conditions under which the shoot of one year does not die back ? Nothing is known about the matter, but the necessity of regenerating the forests is urgent. As an experiment, admittedly with rather faint hopes of success, the writer had trenches 1 ft. wide by 2 ft. deep dug round trees of from 2 to 4 ft. in girth as follows:

EXPERIMENT 1

Coupe 12, *South Central Felling Series, Dhaba Range, South Chanda Division.*

Two trenches were dug in the last week of April round the stumps of trees felled during the previous December. Trenches were continuous, one trench at 3 ft. from the stump and another at 7 ft.

EXPERIMENT 2

Coupe 13, *North Central Felling Series, Dhaba Range, South Chanda Division.*

Three trenches were dug during the third week of May round the base of eight standing trees, one at 3 ft. from the tree, another at 7 ft. and a third at 11 ft. These trenches were not continuous but the short lengths were so sited that every large root from the tree was cut.

The object of the trenches was to cut the superficial roots as is done in the case of sissoo (*Dalbergia sissoo*) in the Punjab to obtain suckers.

The rains broke early in June and suckers appeared on the sides of the trenches furtherest from the stump during the first week of July in Experiment 1 and during the second week of July in

Experiment 2. In August, when the writer counted the suckers, the following were seen :

Experiment 1.			*Experiment* 2.		
Tree 1	.. Suckers	22	Tree 1	.. Suckers	6
,, 2	.. ,,	13	,, 2	.. ,,	Nil
,, 3	.. ,,	1	,, 3	.. ,,	6
,, 4	.. ,,	7	,, 4	.. ,,	Nil
,, 5	.. ,,	12	,, 5	.. ,,	3
,, 6	.. ,,	3	,, 6	.. ,,	2
,, 7	.. ,,	15			
,, 8	.. ,,	8			
,, 9	.. ,,	10			
,, 10	.. ,,	28			

The average height of the suckers was 2 ft. As some of the suckers seemed likely to fall over it appeared that it would be advisable to fill up the trenches as soon as the suckers reached above ground level.

The writer is not at this stage prepared to offer any comments on the experiment, but submits this note to the *Indian Forester* as it may not be generally known that semal gives root-suckers and a cheap method may be available for restocking the forests.

THINNINGS

By W. D. M. Warren, Forest Research Officer,
Bihar.

Dr. Gorrie's article on "Gradation in Thinning Intensity" has opened up a discussion which promises to afford almost as much interest as "The Regeneration of Sal" has done. In his thinnings in coppice crops Nicholson appears to have called down scorn from above with his suggestions that the grades of thinnings officially adopted are based too much on European practice and are unsuited for mixed crops of coppice origin. Yet anyone who has endeavoured

to put thinning theories into divisional practice cannot but have a certain amount of sympathy for him. What he is trying to do is to produce a set of simple rules that "a forest guard can understand." It does not help him much, therefore, to be told that the standard methods and research rules are used by research workers. Nor will many Divisional Forest Officers believe Champion when he says that these can be put into divisional practice, that is, by an average Forest Guard or even Forester.

The disadvantage of the thinning grades is that they can be interpreted in so many different ways. As Gorrie points out, even among senior officers able to understand them, "there is a tendency to label as 'C' grade what each one personally considers a suitable intensity of marking" and "considerable time is spent in fruitless discussion over what actually constitutes a B, C, or D thinning." Laurie corroborates this even for sample plot work. If then the results achieved by highly-trained officers in putting these rules into practice are so different, what can one expect by the untrained and unskilled subordinate staff. Moreover, research workers check their results by the basal area method, but that check could not be applied in divisional practice. Some other check, therefore, is needed to bring such thinning up to a general standard. Otherwise forests might be ruined by over-thinning, or, what is more likely, might not be thinned enough.

Let me give an example of this. Last year, I thinned a young sal pole crop 20 ft. high to 4 ft. $\times$ 4 ft.; at the time both the Conservator and another gazetted offier seemed to think that I had over-thinned, and yet this year the crowns are nearly touching and one can hardly tell that a thinning has been made. It is this rapidity of growth which I think causes Nicholson to say that the grades of thinning officially adopted in India are based too much on Europeon practice. I am inclined to agree with him. For instance, if the diagrams are really meant to show what a forest looks like after thinning, then I would say that "A" and "B" grades are not thinnings at all, that "C" is only a light thinning and that a "D" grade or a light crown thinning is possibly what the crop really requires. But if

Howard's table for Sal High Forest, on page 120 of the Forest Pocket Book, represents a "C" grade thinning, then it will be found on examining Sal II Quality Yield Table that the average height of the tree is about 4¼ times the distance apart of stems. Measurement with a ruler will show that tree numbers 17 and 20 of the "C" grade diagram are correctly spaced according to height and that the length of the whole diagram is a little more than 13½ times this spacing. In other words there should be 13½ trees in the diagram whereas there are 14¾. This means that the "C" grade of the book does not represent Howard's Table of Espacement. But if the "C" grade diagram is reduced to 13½ stems, then the "D" grade thinning is correct with ten stems which is about 75 per cent. of 13½ stems and so conforms to the Research definition of what a "D" grade thinning should be in comparison with a "C" grade.

Howard must have meant those tables to be considered as standard and so our diagrams should be made to conform. The difficulty, of course, is that though suitable for sal, chir pine and probably laurel, they would not suit deodar or sissoo. The stems would be too far apart for the former and too close for the latter. Another difficulty is that the diagrams are supposed to represent trees with normal crowns whereas those in an unthinned forest are very much restricted.

A previously unthinned forest after a Howard's "C" thinning looks more like the diagram of a "D" grade thinning. It would help until our forests have been through one or more thinning cycles if thinner crowns were drawn in the diagrams.

If the standard grades can be criticised for not producing uniform results with different officers owing to the personal factor, so also can Nicholson's rules. I cannot understand why he has discarded the espacement check for his stems of the upper canopy, as that is the only check which a Divisional Forest Officer can impose. In the Singhbhum forests that check is working very well. We are using Howard's tables referred to above, simplified to the formula that 1½ times the diameter in inches is the espacement in feet. It is within 6 inches of being correct for all diameters except the 6 inches and

8 inches classes. Out of the ten species he wishes to encourage this spacing would do for sal and asan (laurel). For *piasal* (*Pterocarpus marsupium*), though slower growing, he would also require it when in competition with faster growing species to keep it from being suppressed. For *gumhar* he would probably require twice the diameter in inches called feet.

If his coppice forest is being grown on the 40-year rotation, and is even aged, then for trees whose light requirements and rates of growth for trees are similar to sal he needs for his final crop a number between 305 stems, A quality coppice, and 463 for B quality, A 12 ft.×12 ft. spacing gives 350 stems and 11 ft.×11 ft., 405 stems. He could thin to 5½′ or 6′ spacing at fifteen years of age and to 11′ or 12′ spacing at 30 years.

Thinnings must not be too mechanical otherwise the best stems might be sacrificed. To safeguard against this, a rule is necessary stating that the best stems will be utilised as centres of espacement.

If espacement rules are used and the best stems preserved, it is extraordinary how little one worries, whether trees are dominant, co-dominants or sub-dominants. Thinning is really very much simplified. Wherever possible Singhbhum rules prescribe a true "C" grade thinning with the removal of the whole of the understorey, but where this cannot be done part of the understorey will be retained, in which case the thinning will conform more to a light crown thinning.

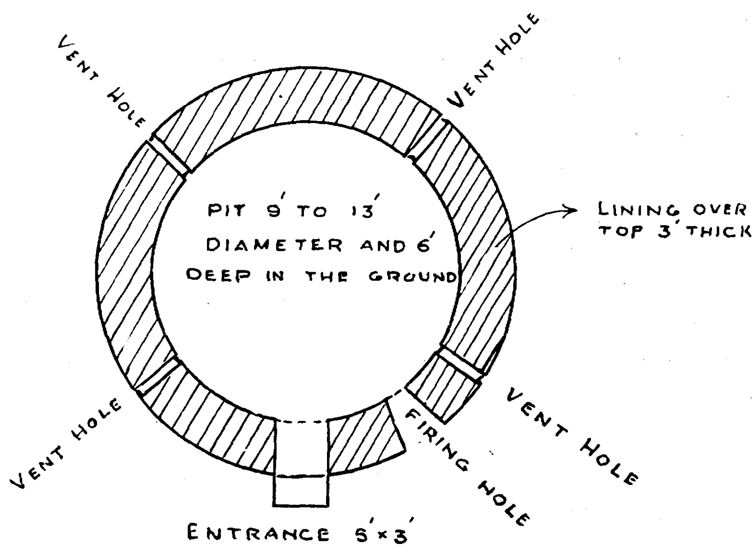
CHARCOAL BURNING IN THE SOUTH PEGU FOREST DIVISION

By A. J. S. Butterwick, D. F. O., South Pegu Division, Pegu.

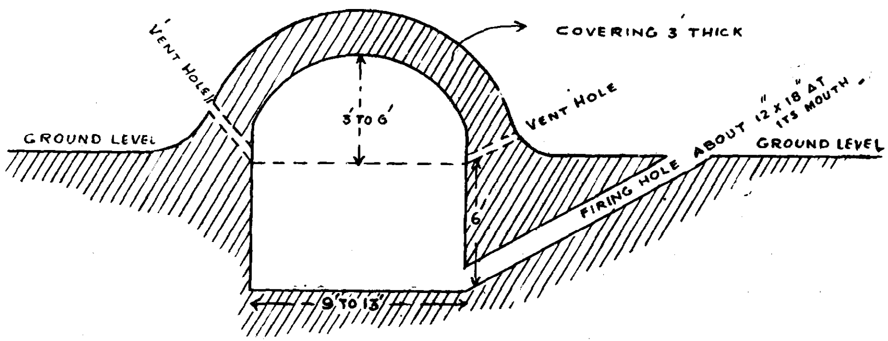
Charcoal burning has in recent years increased extensively in the South Pegu Forest Division. Several methods of burning are practised, but the best is what is known as the "Tayok pho" (literally Chinese kiln).

2. Each kiln is made roughly as follows:

PLAN



CROSS SECTION



Construction of a new kiln.—A pit about 9 ft. to 13 ft. in diameter and 6 ft. deep is dug on high well-drained ground. Billets 6 ft. long and 2 in. to 12 in. in diameter are then stacked vertically in it, care being taken to leave in amongst the feet of the billets a straight space about 12 in. × 12 in. leading from the mouth of the firing hole right across the pit. This space is afterwards filled up with chips of dry

wood and imperfectly burnt charcoal. Over these 6 ft. high billets is then built with other billets a semi-circular dome about 3 ft. to 6 ft. high in the centre. The billets on the top layer are stacked either vertically or horizontally.

Over the top billets are then packed wet straw and large leaves like those of *zinbyun* (*Dillenia pentagyna*) and *in* (*Dipterocarpus tuberculatus*). Then large balls made of clayey earth mixed with water are thrown on the leaves and thoroughly beaten into shape so as to form a semi-circular dome of about 3 ft. in thickness at the top.

This dome gets well-baked in the first burning of the kiln and remains firm for many years. During the rains each kiln is covered with a thatched roof.

About 4 holes each 3 in. to 6 in. in diameter and situated equidistantly are provided for in each dome covering.

Burning in an old kiln.—After the stacking of the billets is complete, the entrance, which is about 5 ft. × 3 ft. (see plan), is walled in with bricks. The kiln is then set fire to through the firing hole. When the billets are completely on fire as may be observed from the dense smoke coming out of the vent holes and from between the bricks at the entrance, the latter are then plastered over with a mixture of clay and water. The mouth of the firing hole is also similarly closed up. When the smoke from the vent holes becomes bluish and almost invisible and when a thick black resinous substance is deposited round them, the charcoal burners know that the burning is finished and promptly close up all the vent holes. A kiln of 13 ft. diameter takes about 8 days to burn. During the burning the brick walls at the entrance and at the mouth of the firing hole have to be watered twice daily—once in the morning and once in the evening. After the vent holes have been closed up, the kiln is allowed to cool for 7 or 8 days. At the end of that time the brick wall at the entrance is broken down and the charcoal taken out. When a kiln is first opened great care must be taken to see that there is not even a spark of fire left inside, for with the ingress of fresh air this spark will be fanned into activity immediately. It was noticed by the writer that the burning takes place first in the top layers of the billets and gradually

moves downwards. Unburnt pieces are generally found near the bottom of the pit.

Species used.—The following species are used for charcoal burning in this Division :

Very good.

Myaukchaw (*Homalium tomentosum*), *maniawga* (*Carallia lucida*), *taukkyan* (*Terminalia tomentosa*), *taungthayet* (*Swintonia floribunda*) *petwun* (*Berrya ammonilla*), *thitpayaung* (*Nauclea excelsa*).

Good.

Paukseinyo (*Dalbergia ovata*), *linyaw* (*Dillenia* spp.), *pokthinmamyetkauk* (*Derris robusta*), *thitsein* (*Terminatla belerica*), *thitsi* (*Melanorrhoea usitata*), *nanlingyaw* (*Cinnamomum* spp.), *zinbyun* (*Dillenia pentagyna*), *binga* (*Stephegyne diversifolia*), *nagye* (*Pterospermum semisagittatum*, *hmaik* (*Alangium begoniifolium*), *kanazo* (*Baccaurea* spp.), *yindaik* (*Dalbergia cultrata*), *thabyè* (*Eugenia* spp.), *myaya* (*Grewia microcos*), *nabè* (*Odina wodier*), *tauksha* (*Vitex* spp.), *thetyingyi* (*Croton oblongifolius*), *banbwè* (*Careya arborea*), *nyaung* (*Ficus* spp.), *kyetyo* (*Vitex* spp.), *kywetnwe* (*Calycopteris floribunda*), *sansè* (*Linoceira terniflora*), *kywedanyin* (*Millettia atropurpurea*).

Not good.

Kanyin (*Dipterocarpus* spp.), *yemane* (*Gmelina arborea*), *kabaung* (*Strychnos nux-blanda*).

General.

From the above it will be seen how useful and paying such charcoal kilns are for cleaning up the rubbish from a Reserve especially from *taungyas* after they have been burnt.

The cost of making a battery of three "Tayok pho" is about Rs. 160 in this division and this is the main item of expenditure. If the kilns are made well and on high ground they can be used, if covered with thatch, during the rains and will last about 5 years. The

percentage of charcoal obtained is high, and charcoal, being extensively used in the larger towns, finds a ready market there.

One headman and two assistants can look after 6 kilns easily. For economical working it is best to have the kilns in sets of three so that whilst one lot are burning, the second lot may be cooling and the third being packed.

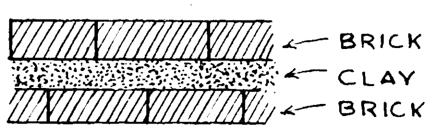
Photos are attached showing some of the kilns erected near one of the regeneration centres in this Division.

COMMENTS ON THE ABOVE ARTICLE BY S. RAMASWAMI,

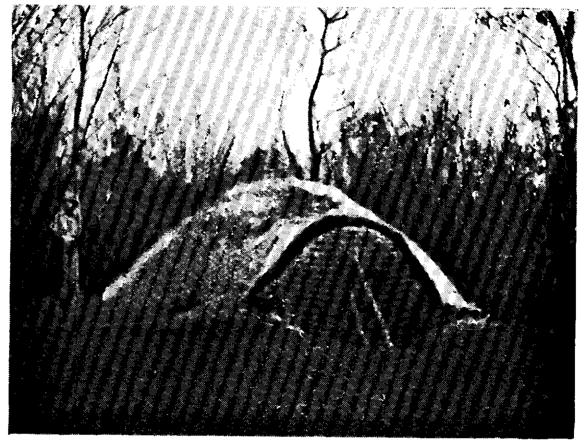
MINOR FOREST PRODUCTS SECTION, F.R.I.

The " Tayok pho " or Chinese kiln described in the article appears to be very simple to make and use and could be used in various forest divisions in India, provided the soil is suitable for making the permanent covering. Only the construction of the permanent outer covering requires some practice ; otherwise, the kiln is simple enough to be worked by ordinary forest labour.

Mr. Butterwick mentions that when the kiln is burning, the brick walls at the entrance and at the mouth of the firing hole have to be watered twice daily, once in the morning and once in the evening, obviously to keep them air-tight. A better method which dispenses with the use of water altogether would be to make the brick wall two bricks thick with a hollow about an inch and a half in the centre, as shown in the diagram above. This hollow, if filled with dry powdered clay and rammed lightly, will keep the wall absolutely air-tight.

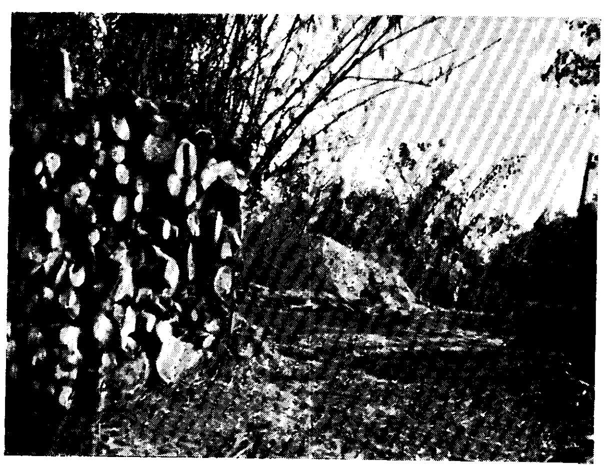


The yield of charcoal obtained with the kiln is not given. Details of a trial burning, with the wood and charcoal weighed, and their moisture content determined, would have added to the usefulness of the article. The author may kindly send this information, if available, to the Forest Economist, Forest Research Institute, Dehra Dun.

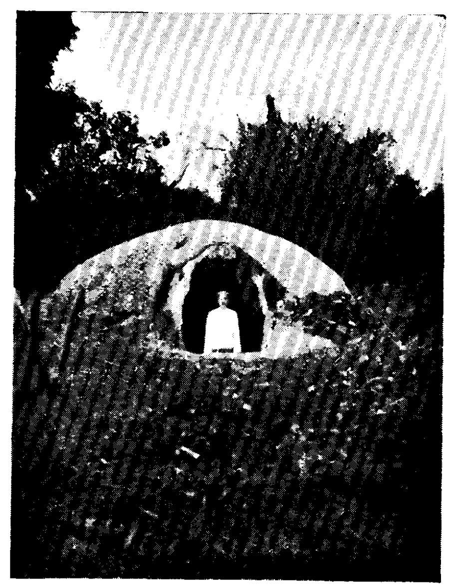


2. SHEWING A CHARCOAL KILN BURNING. SMOKE IS COMING FROM THE VENT HOLES.

1. SHEWING A CHARCOAL KILN COOLING. NOTICE WALLED UP ENTRANCE.



3. SHEWING CHARCOAL KILN READY TO BE PACKED AND STACKS OF BILLETS FOR THE PACKING.



4. SHEWING CHARCOAL KILN EMPTY AND WAITING TO BE PACKED.

A. J. Butterwick,
Deputy Conservator of Forests.

BEAUTY AND THE BEAST—A TALE OF A GALLANT BEAR

By S. S. O.

In the folk-lore of many countries the bear is endowed with several qualities that do not on the whole do him much credit. He is usually represented as a fierce, vicious and foolish creature who is constantly being hoodwinked by foxes, monkeys and other animals, attributes consistent with his natural character and habits. Yet he frequently plays the hero and beautiful princesses and handsome princes often assume his grisly ursine form to captivate equally charming knights and dames. He has also the fabled reputation of having a strong penchant for beautiful maidens with whom he loves to be frolicsome and gallant. This last legendary attribute was recalled from the fog of the sub-conscious when the following tale was told me by a pretty Karen girl. I have no reason to doubt its veracity, particularly, as she herself, a member of an unimaginative tribe, played the principal part in the tragic comedy that was enacted in a region known to be very commonly frequented by bears, and, as I learnt later, was prostrated for a couple of months from the shock of the experience.

The Karens, it may be mentioned, are essentially a hill tribe that inhabit the hills of Lower Burma. They are a thorn in the flesh of the Forest Department owing to their predilection for that destructive method of agriculture known in reports and officially as "shifting cultivation," but where a certain restraint is unnecessary it is referred to less fastidiously by members of the Department. It is a method that is common to most primitive peoples.

A patch of forest, virgin, if possible, is chosen and cleared. The fellings are allowed to dry for a couple of months and then burnt. The fiercer the fire the better. It serves the treble purpose of killing weeds, getting rid of all the felled timber easily and expeditiously and enriching the soil. Just before the rains the *nats* or spirits, having been consulted and a propitious day discovered, paddy seed is broadcast. In suitable places in the plot vegetables such as chillies, tomatoes,

bean and pumpkins are planted. The major labours of the family are now over. They watch with complacency and contentment the beneficent monsoons doing their duty. A bamboo hut, its floor raised four or five feet off the ground, is erected in the clearing, which is known as a " ya," and the family move into the hut lock, stock and barrel, where the next six months are spent tending their crops. In due season the paddy is reaped, threshed and stored in a trough made of bamboo matting on the elevated floor of the hut. The hut is now vacated and the family move back to their headquarters in the village. From time to time as occasion demands members of the family visit the " ya," which is now their larder, may be two or three miles distant, and fetch sufficient provisions for their immediate needs. A beautiful Arcadian custom that saves much fatigue and trouble. They know their store in the deserted " ya " is safe from the depredations of man and trust that wild animals will not raid it. Particularly, that wild elephants, who have an uncanny way of scenting paddy, will not discover it, for one visit from these creatures would deprive them of their provisions for a year.

It was during one of these periodical visits to the deserted clearing in the forest to replenish the kitchen of the family that Nori met with her amazing adventure.

One morning in January Nori was asked by her mother to go up to the " ya " and fetch paddy and vegetables. She called her young brother to bring a haversack and accompany her, and providing herself with a basket and a dah, together they took the path that led to their " ya " a couple of miles distant. Chattering light-heartedly they followed the path. It wound its tortuous way giving way to trees, rocks and bushes, under avenues of bamboos, across a dark ravine and along the rocky bed of a stream till arriving near the clearing Nori cautioned her companion, " Go softly, young brother, and we will watch the red barking deer that we always see."

Quietly they crept up to the opening in the thick hedge of uncut jungle formed by the path. The deer was there as they had expected. The slanting rays of the sun lighting his coat made a fulgent patch of

colour as he sauntered carelessly towards the further side of the clearing. They watched silently as he stepped delicately away and disappeared in the thick undergrowth.

They emerged from their hiding and the young brother was set to picking and filling his haversack with chillies, while his sister, leaving her basket at the hut containing the store of paddy, continued towards the spot where the deer had been to collect some vegetables.

Working automatically, her thoughts far away, humming snatches of song she was in the midst of her task near the edge of the clearing when the sound of a cracking twig and a rustling in the bushes caught her ear.

" The little red deer is still there," she thought. "I will sit quiet and watch it," and she sat down at the foot of a tree.

Still and silent she sat in pleasant anticipation of watching the beautiful creature as it came out to feed near her. The bushes in front of her shook and she smiled.

The thick hedge of bushes was rudely and suddenly parted and the smile faded from her face as the black, shaggy head of a bear appeared in the opening.

Her first instinctive thought was of flight, her second to sit still, and as she watched the huge head shaking slowly from side to side in its frame of leaves and the small peering eyes, she pressed close against the base of the tree praying that they would not find her. But her red *longyi* was a conspicuous mark against the green of the jungle, even to the short-sighted eyes of the bear.

Slowly he emerged from the bushes and lurched clumsily towards the terror stricken shrinking girl who watched his movements with fearful staring eyes. She tried to cry out but no sound escaped her lips.

" His red tongue was hanging out of the side of his open mouth," said Nori when she told us of her adventure one dull, rainy monsoon evening, " and he appeared to be laughing, and his little eyes were twinkling like bright stars in a black sky. I couldn't move, I was so

frightened, but even then I thought he seemed very jolly. But when he came closer and stood up on his hind legs, that, somehow, made me stand up too, and I got up and ran behind the tree.

" He followed me slowly and opened his great hairy arms, and I saw the sun glinting on his long curved claws. He was so close I could smell him, and see the roughness of his red tongue and the twitching of his snout. But he still seemed to be laughing. He rested his paws on the tree and thrust his head sideways round the trunk to look at me, and then he began moving round towards me. I moved too so as to keep the trunk of the tree between us. Still upright, his paws resting on the trunk of the tree he shuffled round towards me, and as I stared at his face the merry expression of it made me think of a game we played in the village, and for a moment I imagined that it was the laughing face of one of my friends that was peeping round the tree.

" Two or three times, though it seemed as if it had continued for hours, we circled the tree in this manner. I began to feel weak and faint and knew that I would fall and he would catch me. Desperate to escape, it occurred to me suddenly to climb the tree before my strength failed completely. It was a thick, crooked tree and easy to climb. So I scrambled up and, quivering and breathless, dropped down on a thick branch.

" The bear stood below and looked up at me and shook his great head and seemed to mock at me merrily. Without knowing what I was doing I broke off a twig and threw it at him, and I saw it stick in the long hair of his neck. As if my action had spurred him to a decision, to my horror I saw him begin climbing the tree slowly and deliberately. Dazed, I watched him for a moment unable to move, and then fear brought a little life to my limbs and I began crawling along a jutting out branch. I crawled painfully along as far as I could and then looked back over my shoulder. The bear had reached my first resting place and, like a rope walker, was walking along the branch just behind. Then I hardly remember what happened. I fell off the branch to which I had been clinging and landed in a heap on the

ground. Blindly, I got up to run away and found the bear in my path. He made a step towards me, his arms outstretched, and I cried out loudly. I felt his great hairy arms encircle me and hold me tight; his stiff hair tickled and poked my eyes and ears, his rough tongue licked my face and the smell of him was in my nostrils. After that I remember nothing.

"I learnt many days later that my young brother had heard my cry and hurried to me, but seeing the bear holding me had run home in a great fright and told my parents that I had been killed by a bear. They hurried to the 'ya' and found me lying beneath the tree in a dead faint but quite unharmed. I was ill and in bed for two months after my terrible experience, and was delirious for many days, but in my delirious and wandering talk, they told me, I always spoke kindly of the bear."

REVIEWS

FAUNA OF BRITISH INDIA, NEMATODA I, ASCAROIDEA AND STRONGYLOIDEA

By H. A. Baylis.

Certain Nematodes or Threadworms cause a number of remarkably unpleasant diseases in man, and in domestic and other animals; some are free-living, feeding on decaying vegetable matter while others often cause very considerable damage to the roots of cultivated plants. On the other hand, one group, the Mermithidae, the larvae of which live in the body-cavity of insects, are undoubtedly of value in checking the multiplication of noxious insects; of a large sample of caterpillars of the teak defoliator *Hyblaea puera* at Saugor, C. P., approximately 50 per cent. were found to be attacked by Nematodes of this family.

This volume by Dr. Baylis gives all that is known of the systematics of two major groups of Indian Nematodes; keys and profuse text figures are provided. In addition the very interesting Introduction discusses such subjects as bionomics, life-history, relationships between parasitic Nematodes and their hosts, and technique.

The author remarks there is still room for a great deal of work in Helminthology, for the rich fauna of India still remains largely unexplored from the parasitological point of view.

J. C. M. G.

FOREST FLORA OF SOUTHERN NIGERIA

BY JAS. D. KENNEDY, SILVICULTURIST, NIGERIAN FOREST SERVICE.

(*Pp.* 242 + *xxiv* + *x*. *Lagos*, 1936.)

It is thought that Forest Officers generally prefer using a Forest Flora written by a Forest Officer rather than one written by a high-brow botanist which would probably have a lot of confusing name-

changes and new hair-split species. It is not only for this reason, however, that Forest Officers and others in Southern Nigeria will like using this book for it contains a great deal of information, the "outcome of the note-taking habit covering a period of ten years," of the kind that Forest Officers usually find useful. The purely botanical side has been reduced to a minimum for the descriptions are written in simple non-technical language and botanical references, usually never looked at by Forest Officers and amateur botanists, have been omitted. These references can always be obtained, if desired, by the more serious systematist from the recently published Flora of West Tropical Africa which this flora follows. The identity of the plants is based on herbarium specimens, mainly collected by the author, the numbers of which are quoted for nearly all the species. In an appendix various field notes and observations and field and botanical characters as well as keys to the Nigerian *Meliaceae* and *Entandrophragmas* are given; this is followed by indexes to the vernacular names and to the scientific and European names and a good few blank pages are thoughtfully provided at the end of the book for recording notes. The book, produced by the Government Printer at Lagos, is well got up and should prove useful to the local Forest Officers.

C. E. P.

INDIAN WILD LIFE, VOL. I, NO. 1

We have pleasure in welcoming a new monthly periodical bearing the above title, which has just been launched as the official organ of the All-India Conference for the Preservation of Wild Life. The Editorial Board consists of Major J. Corbett and Messrs. R. C. Morris and Hasan Abid Jafry. The main objects of this magazine are to create and stimulate among the general public an interest in, and sympathy for, the wild creatures of India, and at the same time to keep alive and give practicability to the resolutions passed at the Delhi Wild Life Conference of 1935.

The magazine itself is of exactly the same size as the *Indian Forester* and it is quite well printed on paper of moderate quality. It contains a number of illustrations, which consist chiefly of portraits of Indian and European notabilities who are giving valuable support to the movement. The price is Rs. 4 per annum or Rs. 10 including membership of the Conference.

The literary contents of the magazine open with a number of messages of good wishes sent by India's leading public men. Then follow "Editorial Notes" of considerable length in addition to a separate "Editorial." There is also a long article by Major Corbett ; a number of extracts from other magazines ; a correspondence section ; and reviews of natural history books. In addition to the above there are pages devoted to children and a proposal to start a "Bird Club" in memory of the late Mr. A. F. Horsman of Cawnpore. All the above matters are ably dealt with and the only small criticism that the reviewer would make is that more care should be exercised in the employment—or rather, the non-employment—of the definite article.

It is an exceedingly difficult task to launch, *and particularly to keep afloat for any considerable period*, a new magazine in which no payments can be made for contributions, and with very little financial backing. The Editors themselves fully realise this and appeal to the general public to be generous in their support. Let us hope that their appeal will not fall upon deaf ears.

F. W. C.

LOGGING—TRANSPORTATION

By Nelson C. Brown, New York.

(John Wiley and Sons, 1936.)

Logging, as the author aptly states, is pre-eminently and fundamentally a problem of transportation, one of moving a bulky and heavy product of forests—logs—from the stump to the sales depots (or saw-mills for further conversion).

Part I deals with minor transportation which is treated in detail under the following sub-heads :

(*i*). Animal-skidding and various skidding devices adopted to facilitate this dragging, devices of hitching logs to drag chains and cables, skidding pans, etc. In India the elephant, buffalo and bullock take the place of horse-skidding described in this chapter. At the end of the chapter the author gives the relative cost of horse-skidding to tractor-skidding based on American experience and effect on advance regeneration by the methods adopted.

(*ii*). Chapter II deals with tractor-skidding and various methods and devices adopted in their use. In India direct dragging by tractors is nowhere practised. A large-scale experiment of direct skidding by a Caterpillar tractor was tried in April 1932 in Kanara Forests of the Bombay Presidency. Indirect skidding by tractors mounted on Winch drum platforms is a regular feature of timber extraction from steep ravines in the Kanara Forests.

(*iii*). Chapter III deals with high lead cable logging systems of various parts of America. In India there is no scope for these methods of extraction as they are practicable only when extensive well-stocked areas are being clear-felled.

Part II deals with problems of loading on vehicles. As long as heavy log transportation in this country is confined to the bullock-cart this problem does not arise under Indian conditions as the cart itself acts as an inclined plane loader.

Part III deals with major land transportation which is sub-divided as follows :

(*i*). Chapter VII deals with chutes. Damage done to timber in dry chutes has led to the abandonment of this method of transporting timber all over the world. Except for shooting of fuel billets chutes have no future.

(*ii*). Chapter VIII deals with wheeled animal transport. In India for heavy log transportation the Indian cart still holds the field and will continue to do so as long as the draught animals are used for agricultural work in rainy season and are available for forest work practically for mere cost of feed of animals.

(*iii*). Chapter IX deals with sleds.

(*iv*). Chapter X deals with motor transport. This is the form of transportation which under certain conditions and for certain class of load is rapidly replacing the bullock-cart. Every year more and more sawn timber, fuel and charcoal is now carried on motor lorries. In a few years motor transportation will monopolize practically all this forest traffic.

(*v*). Chapter XI deals with Forest Tramways and Railways, a specialist job, and contains a lot of useful information for a Railway Engineer. In the Bombay Presidency, 20 miles of meter-gauge Forest Railway is worked on behalf of this Department by the M. & S. M. Railway. Elsewhere Tramways are constructed and maintained by Forest Officers.

Part IV deals with major water transportation problems. In Chapter XIII are described methods of floating and aids to floating adopted in America.

Chapter XIV deals with river rafts and booms and Chapter XV deals with ocean rafts.

Chapter XVI deals with flumes used in hills.

Chapter XVII deals with barges and steamers. Most of the timber exported from Indian ports leaves in flat-bottomed country craft.

At the end of the book a fairly extensive bibliography, indexed according to the methods of transportation dealt with, is appended.

The book is primarily meant as a text-book for American Foresters and its usefulness in this country is strictly limited to the chapters dealing with animal and tractor skidding and motor transportation.

The general get-up and the printing of the book is up to the usual high standard associated with the publications of Messrs. John Wiley & Co.

T. K. MIRCHANDANI.

ABSTRACTS OF INDIAN FOREST LITERATURE PUBLISHED DURING JULY TO SEPTEMBER 1936

ATKINSON, D. J.—*Some experiments on the control of the bamboo shot-hole borer Dinoderus* spp. *in Bamboo dunnage. Burma For. Bull.* 32 ; *pp.* 1—14., 1936.—Certain shipments to England of Burmese teak and *Dipterocarpus alatus* were found on arrival to have been superficially damaged by *Dinoderus* spp. (Bostrychidae). The author gives an account of his investigations and traces the damage to infested bamboo used as dunnage. An account is given of experiments on the water-soaking of bamboo as a control measure and the conclusion is reached that complete and continuous immersion in water for a minimum period of six weeks should provide a control for all practical purposes.—(J. C. M. GARDNER.)

CHATTERJEE, N. C. and G. D. BHASIN.—*Entomological investigations on the Spike Disease of Sandal* (27) *Chrysomelidae (Col.). Ind. For. Rec. (Ent.) I.* (13); *pp.* 243—318, 1936.—This paper lists 243 species of Chrysomelidae frequenting the foliage of sandal, *Santalum album* Linn., collected by the Forest Research Institute survey of the insect fauna of that tree in North Salem, Vellore, Madras and North Coorg Forest Divisions, South India.

Of the 243 species, 158 were found in Aiyur, 133 in Fraserpet, 127 in Jawalagiri and 91 in Kottur. Brief notes on the life history and bionomics are added and a table showing the distribution and abundance of the various species is given. The seasonal incidence and relative abundance of *Hyphasoma tenuilimbatus* Jac. in the various sample plots is graphically represented and discussed. 1 plate with 3 figures.—(AUTHOR'S ABSTRACT.)

GARDNER, J. C. M.—*Immature Stages of Indian Coleoptera* (19). *Anthribidae. Ind. For. Rec. (Ent.) II.* (2); *pp.* 99—111, 2 *pls.*, 1936.—Larval characters, with keys, are given for the following species :

Autotropis modesta conspersa Jord. (Bengal, Dehra Dun), *Androceras khasianus* Jord. (Sadiya, Assam), *Dendrotrogus colligens* Walk. (Ceylon), *D. perfolicornis* F. (Kalimpong,

Bengal), *Eucorynus crassicornis* F. (Dehra Dun, U. P.), *Tropideres luteago* Jord. (Dehra Dun, U. P.), *Tropideres securus* Boh. (Dehra Dun), *Tropideres paviei* Lesne ? (Dehra Dun, U. P.), *Acorynus carinifrons* Jord. (Kalimpong, Bengal), *Rhaphitropis discus* Jord. (Chakrata, U. P.), *Uncifer stigmosus* Jord, (Dehra Dun, U. P.), *Gibber callistus* Jord. (Kalimpong, Bengal), *Meganthribus tessellatus* Jord. (Kalimpong, Bengal), *Stiboderes impressus* Jord. (Kalimpong Bengal), *Araecerus* spp. *Caranistes variegatus* Boh. (Mauritius).—(J. C. M. GARDNER.)

CHATTERJEE, N. C.—*Entomological investigations on the Spike Disease of Sandal* (28) *Cicadidae* (*Homopt.*). *Ind. For. Rec.* (Ent.) *II.* (3) ; *pp.* 115—124, 1936.—This paper lists eleven species of Cicadidae frequenting the foliage of sandal, *Santalum album* Linn., collected by the Forest Research Institute survey of the insect fauna of that tree in North Salem, Vellore, Madras, and North Coorg Forest Divisions, South India. Short notes on the swarming period, bionomics, etc., of the common cicadas are given.

Experimental results rule out the Cicadidae as vectors of the spike disease.—(AUTHOR'S ABSTRACT.)

GARDNER, J. C. M.—*New Indian Cerambycidae. Ind. For. Rec.* (*Ent.*) *II.* (4) ; *pp.* 127—140, 1936.—This paper lists 14 new Indian species as given below :

Obrium unicolor (North Salem, Madras), *Necydalis indica* (Chakrata, United Provinces, 8,000 ft.), *Molorchus darjeelingensis* (Darjeeling, Bengal), *Molorchus hederae* (Punjab : Kulu, 8,500 ft.), *Epania cingalensis* (Ceylon, Mahaoya), *Epania mundali* (Mundali, Chakrata, United Provinces), *Leptepania indica* (Madras: Anamalai Hills, Madras, Palghat), *Perissus bauhiniae* (Dehra Dun, United Provinces), *Nida kala* (Dehra Dun, United Provinces), *Eunidia bicolor* (Madras: Vellore, Salem), *Serixia inconspicua* (Kalimpong, Bengal), *Serixia vateriae* (Bombay: S. Kanara), *Nupserha ceylonica* (Ceylon, Ohiya, 5,850 ft.), *Momisis nicobarica* (Car Nicobar).—(J. C. M. GARDNER.)

DRAKE, C. J. and M. E. POOR.—*New Indian Tingitidae (Hemiptera). Ind. For. Rec. (Ent.) II.* (5); *pp.* 141—149, 1 *pl.*, 1936.—This paper lists 17 species, and 1 variety of which 2 genera and 9 species are described here as new :

(*Cantacader cuinquecostata* (Fieber) (Mohamadpur, Roorkee, United Provinces) *Cantacader diffidentis,* (New Forest, Dehra Dun, United Provinces), *Monanthia lupata* (Gujranwala, India), *Physatocheila chatterjeei* (United Provinces, Chakrata Division, Bodyar, 8,300 ft.), *Physatocheila dryadis* (Ramgarh, 7,000 ft. Naini Tal, United Provinces), *Trachypeplus malloti* (Dehra Dun, United Provinces), *Trachypeplus jacobsoni* Horvath (Dehra Dun, United Provinces), *Cystocheila delineatus* (Distant) (Dehra Dun, United Provinces), *Eteoneus sigillatus* (Haldgaddi, Kalagarh Division, United Provinces), *Dasytingis.* gen, nov. with genotype *D. rudis* var. (Rahatgaon, Hoshangabad, Central Provinces), *Tingis beesoni* Drake var. (Dehra Dun, New Forest, Baihar Balaghat, C. P., Chichawatni pln., Montgomery Division, Punjab, N. Toungoo, Burma), *Jannaeus cuneatus* Distant (Dehra Dun, United Provinces), *Phyllontichila ravana* Kirkaldy (Nilambur, Madras Presidency), *Belenus dentatus* (Fieber), (Selangor, Federated Malay States, Kaula Lumpur), *Teratochila,* gen. nov. with genotype *T. puerilis,* (Rahatgaon, Hoshangabad, Central Provinces), *Derephysis gardneri,* (United Provinces, Chakrata District, Bodyar, 8,300 ft.), *Stephanities gallarum* Horvath. (Lopchu, 5,000 ft. Darjeeling, Bengal).—(J. C. M. GARDNER.)

VAN EMDEN, F.—*Zwei Neue Callirrhipis Mit ihren Larven (Sandalidae, Col.). Ind. For. Rec. (Ent.) II.* (6) ; *pp.* 151—156, 1936.—The author describes *Callirrhipis (Parennometes) incerta* n. sp. and its larva (Dehra Dun, United Provinces) and *Callirrhipis robusta indica* n.sp. and its larva (Dehra Dun, United Provinces).—(J. C. M. GARDNER.)

KAKAZAI, M. A.—*Standard and Commercial Volume Tables for Dalbergia sissoo. Ind. For. Rec. (Silv.) II.* (2); *pp.* 47—58, 2 *curves,*

1 *pl.*, 1936.—Tables are given shewing the average volume of timber obtainable from trees of different sizes in 4 in. diameter and 10 ft. height classes, based on measurements of 732 trees in natural forests in the United Provinces; also tables for length of bole and bark thickness, and a table for converting girths to diameter.—(H. G. CHAMPION.)

ANON.—*A stand table for chir* (*Pinus longifolia, Roxb.*) *Even-aged High Forest. Ind. For. Rec. II.* (3); *pp.* 59—74, 1 *curve*, 1936.—The percentage of trees in each 1 in. diameter class is worked out for crops in 1 in. crop diameter steps from data available from 234 crop measurements. The numbers of stems per acre in each 1 in. diameter class are worked out for each decade of age from the crop diameters given by quality tables in Howard's Yield Tables. The numbers of trees per 100 acres by 4 in. diameter classes are worked out for rotations of 100, 120 and 140 years on 5 site qualities.—(H. G. CHAMPION.)

CHAMPION, H. G.—*A preliminary survey of the Forest types of India and Burma. Ind. For. Rec. (Silv.) I* (1); *p.* 286, *pls.* 40, 1936.—A classification of forest types is put forward based on four temperature zones, tropical, sub-tropical, temperate and alpine, each sub-divided on available moisture as reflected by the relative importance of evergreen, deciduous and thorny trees. Whilst the form of the tropical forests is similar on both sides of the Tropic of Cancer, the flora is considered sufficiently different to render sub-division into northern (quasi-sub-tropical) and southern variations advisable. Omitting moist and dry alpine scrub, 13 formations are distinguished, seven of them sub-divided into northern and southern variations. The six tropical formations are sub-divided into 33 forest types, most of which are admittedly composed of several associations, these being indicated when possible; important edaphic variants (24) are listed, and successions are discussed leading to the recognition of 12 primary and 10 secondary important seral types. Sub-tropical and temperate forests are similarly dealt with. For each type is given a general description of forest and the locality factors, plant lists for typical

examples, and ecological notes. Many types are illustrated by photographs and references are given to published illustrations for the rest. Pp. x + 286, Pl. 40 and 2 maps.—(H. G. CHAMPION.)

MOBBS, E. C. and S. S. NEGI.—*Effect of resin tapping on the diameter increment of chir (Pinus longifolia). United Provinces For. Bul.* 8; *p.* 10, *App. II*, 1935.—Ring measurement on cross-sections of 100 tapped and 100 untapped trees at 4½ ft. and 15 ft. shewed that the tapping causes an increase in increment at 4½ ft. over that during the two 10-year periods prior to tapping, but a comparable decrease at 15 ft. It is suggested that if an allowance is to be made in fixing rotation, the exploitable breast height diameter might be increased by 2 in. or the rotation by 8 to 10 years.—(H. G. CHAMPION.)

KAPUR, S. N.—*Results obtained with a timber-drying kiln treated directly by furnace gases (Heimpel and Besler's double firing generator kiln). Ind. For. Rec. (Util.) I.* (3); *pp.* 77—92, 2 *pls., figs.* 6, 1936.—This pamphlet describes a furnace kiln and its method of operation and records results of experiments on the seasoning of timber by means of humidified gases from wood fuel after complete combustion with an excess of air. The process is economical in regard to both the period of drying and the cost.—(H. TROTTER.)

KAMESAM, S.—*A note on protecting Indian structural timbers against fire, termites, borers and fungi (rot). Ind. For. Rec. I.* (4); *pp.* 93—113, 1936.—This pamphlet contains a classification of Indian timbers on the basis of their natural durability and the intensity of treatment required for each. The amenability of the timbers to fire-proofing and preservative treatment and the cost thereof are also discussed.—(H. TROTTER.)

ANON.—*Forest Research In India*, 1934-35, *Part II. Provincial Reports, pp.* 1—137, 1936.—The work of the year is reviewed separately for each of the provinces of India under the headings of Silviculture (including Working Plans), Forest Botany, Forest Entomology, Utilisation and Economic Research. Important results are published elsewhere.—(H. G. CHAMPION.)

EXTRACTS

FAILURE IN FORESTRY AND ITS REMEDY

Extracts from a paper "Fundamental cause of our Failure in Forestry and the Remedy" read by Mr. A Koroleff at the conference on Forestry Research (National Research Council), Canada :

"Our greatest difficulty in regard to research, education and practice is with silviculture and, particularly, with its most essential aspect—its intimate relationship to logging. Considering the energetic and even enthusiastic efforts of many of our foresters who have attempted to work in this field, it is at first difficult to understand why practical results are so meagre, so incommensurate with the expenditure of energy, time and money. No pushing from governmental offices or pulling by the foresters on the ground helps. Many become increasingly discouraged.

"As I will explain presently, an enquiry into this matter shows that our silviculture is simply off the track. It was derailed by our lack of that particular knowledge which enables a forester to understand the complex inner life of a forest, to foretell accurately the ultimate effect of his interventions and to select for any given set of natural conditions a cutting practice that will ensure a desirable forest crop. I refer to our quite insufficient knowledge of forest soils and to our utterly inadequate understanding of the intimate and complex relationship between the life of the forest and the physical, chemical and biological factors in connection with the soil.

"*Right and Wrong Methods of Forest Exploitation.*—There are three ways of forest exploitation : (1) a forest can be handled as a mine, cut down and done away with ; (2) it can be treated as an agricultural crop cut down and replanted ; (3) but the term "proper forest management" applies without reservation only to cutting a forest in such a way as to help, or at least to permit, Nature to produce in a reasonable space of time as good a forest crop again.

"The first method, unfortunately, was almost the universal practice in Canada, and it still prevails : the agricultural method has been tried, if on a negligible scale and in spite of the high expense ; the regular forest management method has been attempted here on an increasing scale, but usually with but partial or poor success. Let us compare these three methods in their different essential aspects.

"The first (mining) method disregards the future crop and leads usually, even in the absence of forest fires, to the devastation or at least to the deterioration of a forest. The agricultural method, dependent on artificial regeneration, mostly failed as a basis of forest management and its use is declining. The sustained yield method which depends on obtaining natural regeneration through proper cutting, gives by far the best results and it has been definitely recognized as the sound basis of commercial forest management in all the countries where forestry has been practised with conspicuous success.

"In such countries the first method is not tolerated at all. The second is used on a relatively small and diminishing scale, mainly as an emergency measure and as a necessary evil to correct bad mistakes of past mismanagement and to reclaim valuable denuded forest land. The last method represents there the common practice.

"The first method converts a forest into money ; the second does the reverse; the third gives continuous and usually increasing income.

"Forest 'mining' demands practically no brains or money. Planting requires some knowledge and much money. Getting natural regeneration through appropriate cutting requires very little money but much knowledge of the inner life of the forest. It is this knowledge that we in Canada do not sufficiently possess.

"*Our Outlook on Forest Management, Particularly on Silviculture is Basically Wrong.*—During the last fifteen years I could not but observe very frequently that the outlook on forest management in our profession on this continent greatly differs from that in Europe, while this difference is not fully justified by the difference in the conditions.

"*Why Our Book Silviculture Fails in a Forest.*—Those foresters who think of practising silviculture through logging in terms of our school manuals on silviculture, with their simple and stencil-like description of various standard silvicultural cutting methods, illustrated by diagrams of clear-cutting in strips, selective cutting, etc., are sure to be disappointed. Actually the problem is far from simple.

"Firstly, commercial requirements pertaining to the intricate technique of logging, in which cutting is closely related to and even dependent on transportation, must be sufficiently understood, and, with respect due to them, should be wisely reconciled with the needs of silviculture. This is likely to alter considerably the class-room methods.

"Secondly, the forester will find, if he is at all observant, that over areas of a fair size the forests and forest sites are only as a rare exception more or less uniform ; so that his text-books cannot possibly provide a sufficient number of silvicultural stencils even for the prevailing kinds of forest stands and conditions that he is likely to encounter.

"Thirdly and finally, he should know (otherwise, it may be found with dismay, many years later) that he cannot intelligently select even a more or less suitable cutting stencil from his book collection unless he has adequate theoretical and practical knowledge of various forest soils and of the whole complex relationship between these and the life of the various trees and other plants of the forest.

"It has been quite definitely established in Europe, through centuries of painstaking study and trial, that the effect of a certain cutting method upon regeneration in a stand of a given species and character is highly dependent upon the nature and condition of the soil, and that in many cases even the response of a tree species to light varies with these factors. Therefore, a forester who attempts to choose a proper silvicultural cutting method without due regard to or understanding of forest soil, etc., in a given case, shows merely an ignorance of the fundamentals of silvics and silviculture. Displays of this ignorance in speech, in writing and in handling of our forests, are so common that it would be very easy but quite superfluous to adduce examples or proofs."

"*Complexity of proper Silvicultural Cutting and our Ignorance regarding it.*—Having had no experience in the proper practice of silviculture through cutting, our foresters, as a rule, are not fully aware of its complexity.

A doctor, to be really helpful to his patient, must know thoroughly among many other things, the anatomy and physiology of the human body and its normal and pathological states, the obvious and obscure peculiarities of a given person, and the effects of separate treatments under different conditions. Only if he can correctly visualize the future, the immediate, the more remote and even the distant effects of the application of the various therapeutic means at his disposal, can he deal with his case intelligently.

"Much the same should be expected from a forester who fully deserves this name. He must understand adequately not merely the commercial forest trees but the total complex of forest plants in their involved interrelations and their multitudinous combinations, including the great variety of apparently insignificant plants of the forest floor ; and not only the life of all these plants under the existing conditions but also the transformation in the litter and in various layers of the soil, their physical chemical and biological changes as affected by various cutting methods through the change in light, in moisture, in wind, etc., and as affecting the life and the competition of the plants.

"*Silvicultural Fads and Frills.*—The main and normal channel of constructive silvicultural activity being practically blocked by our lack of key knowledge, our foresters tend often to the 'inferiority—superiority complex' and to posing as scientists. Hence great many silvicultural fads and frills, often carried into the field of research, the listing of which would be merely a waste of time. For typical illustrations poisoning of hardwoods perhaps suffice. Yet things like that are being contemplated or even carried out, while in Canada over a million and a half acres of our forest is cut annually, as a rule improperly, and with very detrimental results due mainly to our lack of basic knowledge and to our failure to give attention to the matters that need it most."

THE IMPORTANCE OF ECOLOGY IN FORESTRY

BY P. S. SIVARAMAKRISHNAN, B.A., M. F. C., 1934—36 DIVISION.

(*Winning essay for the " Indian Forester Prize " for present students of the Madras Forest College, for* 1936.)

What is Ecology?—Ecology is a study of plant communities as they occur in Nature. It takes into consideration the origin, development, function, responses and reactions of plant and animal communities in relation to environment factors in a given locality. Over and above this it seeks: (1) to *observe and record* how the several associations of plants arise and develop in different places and (2) to *find reason* for these associations and the various ways in which they develop.

Ecological Factors which Govern Vegetation.—The ecological factors governing the growth and development of plant communities can be grouped under three broad heads: (1) Physiographic factors such as light, humidity, moisture, slope, aspect, etc. (2) Edaphic factors such as soil moisture, soil population, etc. (3) Biotic factors, *i.e.*, factors caused by plant and animal agencies, action of man, insects, birds, etc. These factors act on the plant as so many stimuli and the plant responds to each one of them.

There is an optimum condition in one or all of these factors which is most suited for the development of a particular community. Sometimes the deficiency in one factor may be compensated by the superfluity of some other factor. A favourable atmospheric humidity may sometimes compensate for a deficient rainfall. Ecology in its widest aspects must include not only a comprehension of the physical site factors (climate soil, presence of animal life, etc.) but also the influence of all living agents which react upon the site, the neighbouring vegetation as well as animals and insects. The very plants growing on the site often have a marked influence in modifying the original factors which existed when the plants first arrived. This is a very important consideration. *Dalbergia sissoo* and *Acacia catechu* grow up on recently formed shingle deposits in loose porous soils. Under the light canopy which these species produce, some shrubby undergrowth slowly crops up The accumulation of humus soil which could retain a sufficient quantity of moisture produces conditions suitable for a light deciduous forest. Now due to the influence of earthworms and termites the soil conditions are changed and with this change we may get *Shorea robusta* under the light deciduous forest cover and ultimately sal may establish itself on the site. This sort of natural succession eventually results in a stable vegetation which undergoes no further change so long as the general conditions of the site are not altered. In forestry we have to recognise the various stages in the development of the crop from seedling to maturity. In ecology we have to study not only the growth (development) of an individual tree (as in botany) or of a crop (as in forestry) but we study the history (or attempt to piece together or reconstruct the history) of the locality itself and try to obtain a connected story concerning all the various plant communities which have developed or may arise in the future on that site.

Influence of Animals, Birds and Insects.—We often feel that some of the animals are destructive to forest growth. At the same time no forest officer can fail to realise the necessity of understanding the inter-relations between animal and plant life. Certain trees are dependent on certain insects for pollination and fertilization, *e.g.*, the fig insect or wasp (*Blastophaga*). Insects control production of fruits while it is not uncommon to see some trees killed by insects periodically. In the distribution of seeds we find elephants ejecting the seeds of *Terminalia belerica*, jackal prefering *Ziziphus jujuba* and breaking the pods of *Cassia fistula*, bear ejecting the seeds of *Gmelina arborea* and *Mimusops hexandra*. The destruction of prickly pear by the Cochineal insect has an ecological bearing. Thus if we go on studying the ecological inter-relations of plant and animal life we may be in a position to make proper regulations to protect, reduce, or destroy wild life in our forests.

How does Ecology help us in Practical Forestry.—From the foregoing paragraphs it will be seen that forestry if it is to be practical on a scientific basis, must start off by recognising that forest vegetation is not just an aggregation of trees and other plants brought together by chance but a community which has arisen and developed according to definite biological laws. The art of forestry consists largely in the forester's skill in estimating the sum of the various inter-acting forces upon any one spot and then utilizing them to the best advantage. Thus we see that *forestry is mainly applied ecology* and the progressive development of the art and science of forestry depends on the recognition of ecological foundations.

The Aim of Forest Ecology.—Forestry consists in finding a *practical working agreement* between the wild unmanaged forest and the forest most useful to man. The managed forest is an artificial creation. Therefore it is liable to suffer, like man himself, from various ills—epidemics and various other pathological conditions due to maladjustment. "The natural forest from the time vegetation first starts on a denuded site until the climax forest is attained is in a condition of adjustment" (Toumy). The more the forester understands the natural law of the jungle, the better he will be fitted to make the necessary adjustments. When man attempts to work a natural forest with the idea of increasing its economic value he will have to interfere more or less with the natural adjustment that is in progress towards its climatic climax (*i.e.*, the ultimate expression of a particular environment). His actions may do good or harm to the forest. Some of his operations which are favourable economically (large scale fellings during times of war or boom) may be unfavourable from a silvicultural point of view. Though one may argue that after all we manage our forests to get the maximum economic value out of it, none can deny that we could ignore the basic laws of forest reproduction and growth in the natural forest. We should study the history of the natural forest in order that we may be in a position to see what operation can be undertaken and carried forward in our attempt to increase forest revenue without seriously interfering with (or destroying altogether) the equilibrium which exists between forest growth itself and the climate, soil and other site factors enumerated in a previous paragraph. But Nature is infinitely variable. The site factors vary from place to place. Foresters in the past have been rather apt to go by rule of thumb and to force upon Nature a too rigorous and uniform a policy. It is only in comparatively recent years that foresters have shown a tendency to permit a wider and more varied scope to the vegetation under their control. The vegetation present on a site is the expression of the site factors operating on it. We see it for a short time and go away. We rarely perceive the gradual imperceptible changes that take place on it. Ecologists recognise that most types of vegetation are transitory, that different phases (or growth forms) arise, develop and mature and give place to others (*vide* the example of sal forest elsewhere). Ultimately a climax type of vegetation is reached, which is the final expression of the various climatic and other factors operating on the site and it differs from the preceding types in that it is stable or permanent.

When a doubt occurs whether any land is fit to keep as forest land or not the answer is best given after an ecological survey which should aim at finding the climax vegetation of the site. Such a survey will be able to tell us something about the past, present and the future of the site and once the survey is finished, the formulation of grazing and possibilities of the site can be roughly known. This survey can best be done during the preparation of a Working Plan for the tract concerned, but it need not necessarily await a regular Working Plan. One of the problems which will face the Working Plan Officers is to decide whether or not the economic forest—that which yields the greatest financial returns—is the climax type. If it is, he must take every measure to ensure that adequate protection is afforded to the forest against outside influences. He must also regulate the fellings very carefully to ensure that

the requisite conditions for regeneration of the crop are obtained. *He must ensure that the climax conditions are not seriously disturbed during the fellings or so as to throw the succession back to an earlier stage inimical to the regeneration of the desired species.* When evergreen rain forests (such as those found in Ghat Forests of Palghat Division and in Canara) are too rapidly cleared and burnt we fail to get the species that are felled and we find to our amazement a deciduous forest on the site. Dibbling with *Hopea parviflora* and *Artocarpus hirsuta* fail to come up on a rain forest site. The reason for this is that: (1) The succession is thrown back; (2) The organic matter, like humus, bacteria, etc., is destroyed; and (3) The evergreen undergrowth fails to come up immediately when the soil gets exposed and deteriorated.

It often happens, however, that the economic forest is not the climax type. In this case it will be necessary for the forester to take steps to arrest the normal development of the vegetation at a stage most suited to the object of management and keep it there. For instance in some forests of the West Coast (and most other localities such as Burma or Assam) there is a marked tendency for many deciduous hardwood forests to develop under protection first into moist deciduous forests with an evergreen understorey, then into the semi-evergreen and perhaps finally evergreen formation due to the production of conditions unfavourable to the perpetuation (regeneration, etc.), of deciduous species and favourable to the invasion of numerous soft-wooded and valueless evergreen species which flourish under shade conditions. This might be arrested by the encouragement of ground fires to destroy the evergreen species and to bring in grass or perhaps clear-felling the mature crop will be adequate, *provided weed growth can be controlled.* In some places conditions suitable for the spontaneous invasion of hardwood evergreen species of economic value like *Mesua ferrea, Hopea parviflora, Artocarpus hirsuta* might be found. In such cases it is probably easier to work along with nature than against her. Wherever possible this rule should be followed. It does not matter whether regeneration is to be mainly natural or artificial. *No working plan can be worked successfully unless the prescriptions ensure that adequate conditions shall exist for the germination and growth of the species which it is proposed to regenerate or perpetuate.* Many past working plans—notably in sal regions—have failed due to the lack of appreciation of essential ecological foundations for the prescriptions laid down with the result that regeneration was not obtained *at the time and place* where it was required. The regeneration of sal is primarily an ecological problem.

Then one of the things a student of forestry learns very soon in his experience is that general rules of thumb laid down for working a forest in one district do not apply when he is transferred to another district. In silviculture, only principles with general scientific foundations are applicable everywhere. Local rules (the result of observation and experiment in that locality) are not universally applicable. A student versed in ecological foundations is more versatile (or adaptable) to changed situations for he has learnt the habit of close observation of natural conditions and can apply himself to new problems promptly. For instance, if a student who had learnt only the technique of teak regeneration on the West Coast were to be posted

to a teak district in Central Provinces, where very different conditions prevail, he would find himself seriously at fault there. In the first instance teak is regenerated there almost entirely in the open : in the dry hot districts of Central India, regeneration of teak is secured under some form of shelter wood!

In complex pathological problems such as the spike disease in sandal an ecological survey will help to control spike disease to some extent. It is observed that the spread of spike disease depends on the ecological make up of the area. Some of the host plants of sandal like *Azadirachta indica. Semecarpus anacardium*, *Cassia siamea* either neutralize the action of the virus (spike disease is classed as a virus disease) or provide no attraction for the virus in their association. The application of ecological principles to the silvicultural control of Lantana is worthy of interest. Bamboo, one of the few tolerent species under Lantana, is put under Lantana thickets and tended until it dominates the Lantana and finally kills it.

The yield possibilities of a given site is determined by its most unfavourable factor. The improvement or mitigation of this factor is the first step that the forester should take to make his forest more productive. The yield from a *Eucalyptus globulus* plantation grown on a grassland type of soil is found to be only $\frac{2}{3}$ of the yield for the same age and area and species grown on a *shola* type of soil. The growth on grassland type is stunted and whippy and there is a marked absence of undergrowth except perhaps *Eupatorium glandulosm*. Soil profiles have been collected in our Ooty camp for analysis at Coimbatore.

Thus we see that Nature has developed such associations which the habitat factors of the locality would permit. The more profound our knowledge about the life history of our forests in all its aspects, the less will be our every day difficulties. In the preparation of a Working Plan we find ecological surveys useful. Part I of a Working Plan gives a summary and appreciation of the various factors affecting the forest for which the " Plan " is made. In the words of Mr. Troup " the development of ecology as a science has given a special impetus to the study of physical and physiological conditions bearing on natural regeneration. In ecological language regeneration fellings are nothing more than a process of stimulating succession of a required kind. In order to achieve success it is necessary to study the conditions under which this can be affected by a partial or complete removal of the forest cover, resulting in the reduction of root competition, the admission of light, warmth, and precipitations and the alteration of soil conditions. " There is much scope for research in the study of ecological problems and the progress of Indian Forestry depends on the amount of ecological research that we do.

Aknowledgment.—My thanks are due to Capt. P. W. Davis, I.F.S., Principal. Madras Forest College, Coimbatore, for the masterly way in which he expounded silviculture on ecological foundations both in the class room and in the forest. But for his unabated interest in the subject and emphasis of the ecological concept towards biological facts I doubt much whether I will be able to write an essay on the subject at all.—(*Madras Forest College Magazine*, Vol. XX, No. 4, June 1936.)

HASTENING GERMINATION OF ACACIA SEEDS BY SOAKING IN BOILING WATER

Experiments reported in the *Agricultural Gazette of New South Wales*, 47, Part I, show that for effective and rapid germination in the case of certain acacias (*Acacia baileyana, Acacia aneura*, and *Acacia elata*) soaking in boiling water is found very satisfactory. In the case of the first it was found that even six years old seed will not germinate unless the hard outer coat is softened by intense heat. Untreated seed was compared with (1) seed soaked in cold water for thirty minutes, (2) seed soaked in cold water and the water then brought to the boiling point, (3) water brought to the boiling point and seed immersed and allowed to remain for ten minutes with the heat turned off, and (4) seed placed in boiling water and boiling continued for ten minutes. It was found that the germination in the last three treatments was from 80 to 90 per cent. while the cold water soaking and the control gave less than 10 per cent. It also made very little difference if the seed was only two years old or was six years old.—(*Current Science, April* 1936).

FIRE-RESISTING WOODS

Official announcement is made this week of the approval of additional Empire timbers by the London County Council for use as fire-resisting materials as understood in connection with the London Building Act.

From the point of view of fire risks in buildings, certain structures, *e.g.*, classes of doors, shutters, staircases, landings, beams and posts, verandahs and balustrades, flooring, etc., are regarded as key components, and the importance of constructing these things of materials offering a high degree of resistance to fire has often been stressed. To meet the requirements of the London Building Act, the components in question, if constructed of timber, must be made from approved fire-resisting woods, *e.g.*, teak, jarrah, etc.

With a view to extending the use of selected Empire timbers for building and other purposes, the Imperial Institute Advisory Committee on Timbers some time ago submitted to the London County Council for tests a number of Empire timbers considered as likely to offer a marked degree of resistance to fire, and, as previously announced, the following were in due course approved as fire-resisting materials: Iroko and African walnut from British West Africa, mora and crabwood from British Guiana, and Andaman padauk.

Recently, the Advisory Committee submitted a further series of selected Empire woods for similar tests. The results are now available, and it is desired to bring to the notice of all interested that the following additional Empire timbers have been approved by the London County Council for use as fire-resisting materials as understood in connection with the London Building Act: Queensland maple, Seccondee (Sekondi) mahogany from the Gold Coast, pyinkado from Burma, Andaman pyinma, red meranti from the Federated Malay States, English ash.

Samples of these woods are available for inspection by the public, and information regarding them is available at the Imperial Institute, South Kensington, London, S.W.7.—(*Timber Trades Journal, 8th June* 1935.)

The following information is extracted from the *Seaborne Trade and Navigation of British India*, for August 1936—

IMPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	Month of August			Month of August		
	1934	1935	1936	1934	1935	1936
Wood and Timber				R	R	R
Deal and pine wood.. cubic tons	589	662	3,283	37,769	37,112	2,02,919
Teakwood—						
From Siam .. cubic tons	212	..	31	23,029	..	4,586
,, Indo-China ,,	..	390	40	..	45,687	5,622
,, Other countries ,,	..	..	466	..	..	56,320
Total .. ,,	212	390	537	23,029	45,687	66,528
Sandalwood .. .. ,,	36	20	7	10,086	6,295	1,722
Other kinds of wood and timber, including firewood, timber for match-making and plywood, etc. .. ,,	..	..	..	43,163	1,27,466	1,17,886
Manufactures of wood, including wood-pulp and tea-chests *other than* furniture and cabinetware .. ,,	..	..	..	4,33,956	4,82,196	3,20,845
Total ..	..	..	..	4,87,205	6,15,957	4,40,453
Total of Wood and Timber ,,	..	..	..	5,10,234	6,61,644	5,06,981

EXPORTS

PRINCIPAL ARTICLES	QUANTITY			VALUE		
	MONTH OF AUGUST			MONTH OF AUGUST		
	1934	1935	1936	1934	1935	1936
WOOD AND TIMBER—						
Teak wood—				R	R	R
To United Kingdom, cubic tons	1,723	2,273	3,904	4,30,289	4,18,366	7,88,571
,, Germany .. ,, ,,	277	462	393	66,039	1,10,880	91,537
,, Belgium .. ,, ,,	43	55	32	8,536	10,450	7,160
,, Iraq .. ,, ,,	83	60	89	16,210	10,897	15,297
,, Ceylon .. ,, ,,	163	77	98	18,937	8,508	11,496
,, Union of South Africa .. ,, ,,	151	299	387	33,287	48,072	68,263
,, Portuguese East Africa .. ,, ,,	..	10	59	..	2,150	9,880
,, United States of America .. ,, ,,	4	20	..	1,110	4,496	..
,, Other Countries ,, ,,	422	349	417	80,225	68,696	86,529
Total .. ,, ,,	2,866	3,605	5,379	6,54,633	6,82,515	10,78,733
Share of Bengal ..cubic tons	..	12	..	..	3,118	..
,, Bombay .. ,, ,,	100	125	70	20,675	19,450	13,917
,, Sind .. ,, ,,	..	..	2	..	..	444
,, Madras .. ,, ,,	1	..	35	100	..	8,071
,, Burma .. ,, ,,	2,765	3,468	5,272	6,33,858	6,59,947	10,56,301
Total .. ,, ,,	2,866	3,605	5,379	6,54,633	6,82,515	10,78,733
Teak Keys .. tons	259	312	400	38,888	46,752	56,150
Hardwood (*other than* teak) and manufacture of wood *other than furniture and cabinet-ware*	..	..	..	41,377	57,450	91,355
Total ..	..	..	..	41,377	57,450	91,355
Sandal wood—						
To United Kingdom .. tons	1	..	1	1,200	600	1,000
,, China (*excluding* Hong-Kong) .. ,,	..	..	14	..	..	14,880
,, Japan .. .. ,,	..	..	..	..	..	..
,, Anglo-Egyptian Sudan ,,	2	13	5	2,760	17,900	6,085
,, United States of America .. .. ,,	20	15	72	23,000	16,060	99,048
,, Other Countries .. ,,	..	4	1	325	4,203	2,444
Total .. ,,	23	32	93	27,285	38,763	1,23,457
TOTAL OF WOOD AND TIMBER AND MANUFACTURES THEREOF ,,	..	..	..	7,62,183	8,25,480	13,49,695